FIG. 1A

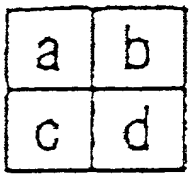

FIG. 1B

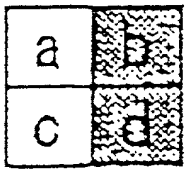

FIG. 1C

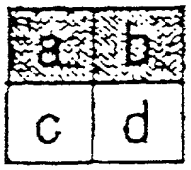

FIG. 1D

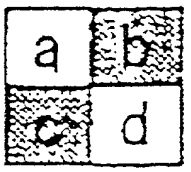

FIG. 1E

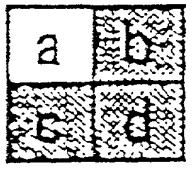

FIG. 2A

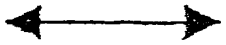

FIG. 2B

FIG. 2C

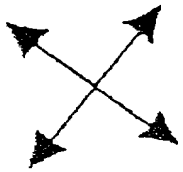

FIG. 3

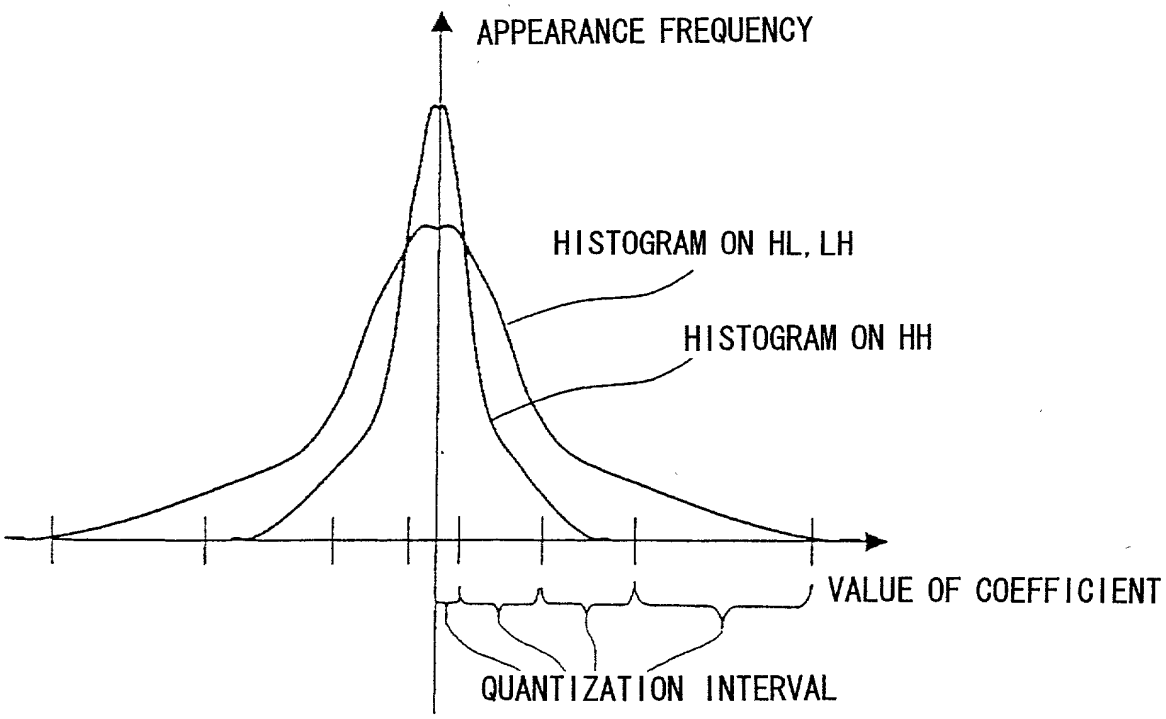
APPEARANCE FREQUENCY
HISTOGRAM ON HL, LH
HISTOGRAM ON HH
VALUE OF COEFFICIENT
QUANTIZATION INTERVAL

FIG.4

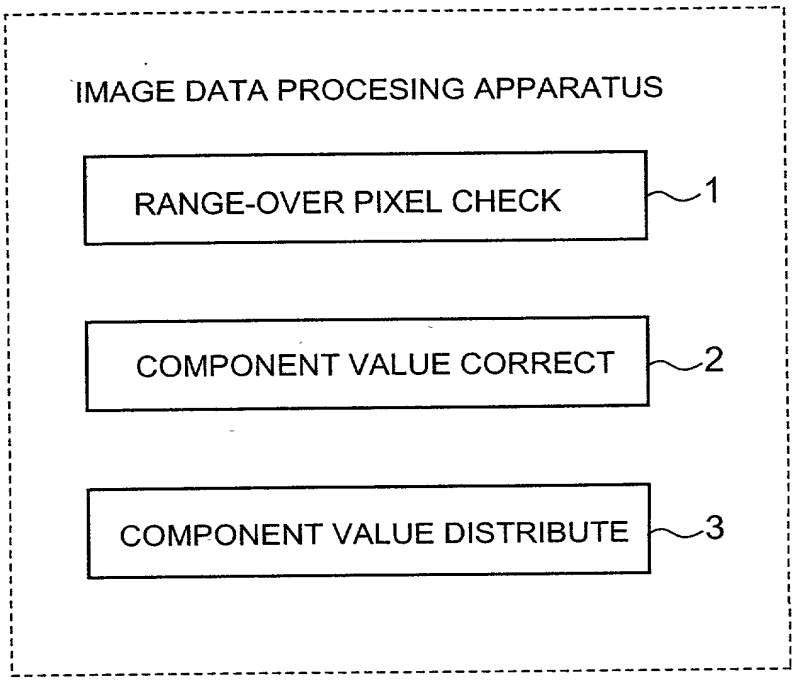
IMAGE DATA PROCESING APPARATUS
RANGE-OVER PIXEL CHECK
1
COMPONENT VALUE CORRECT
2
COMPONENT VALUE DISTRIBUTE
3

FIG.5A

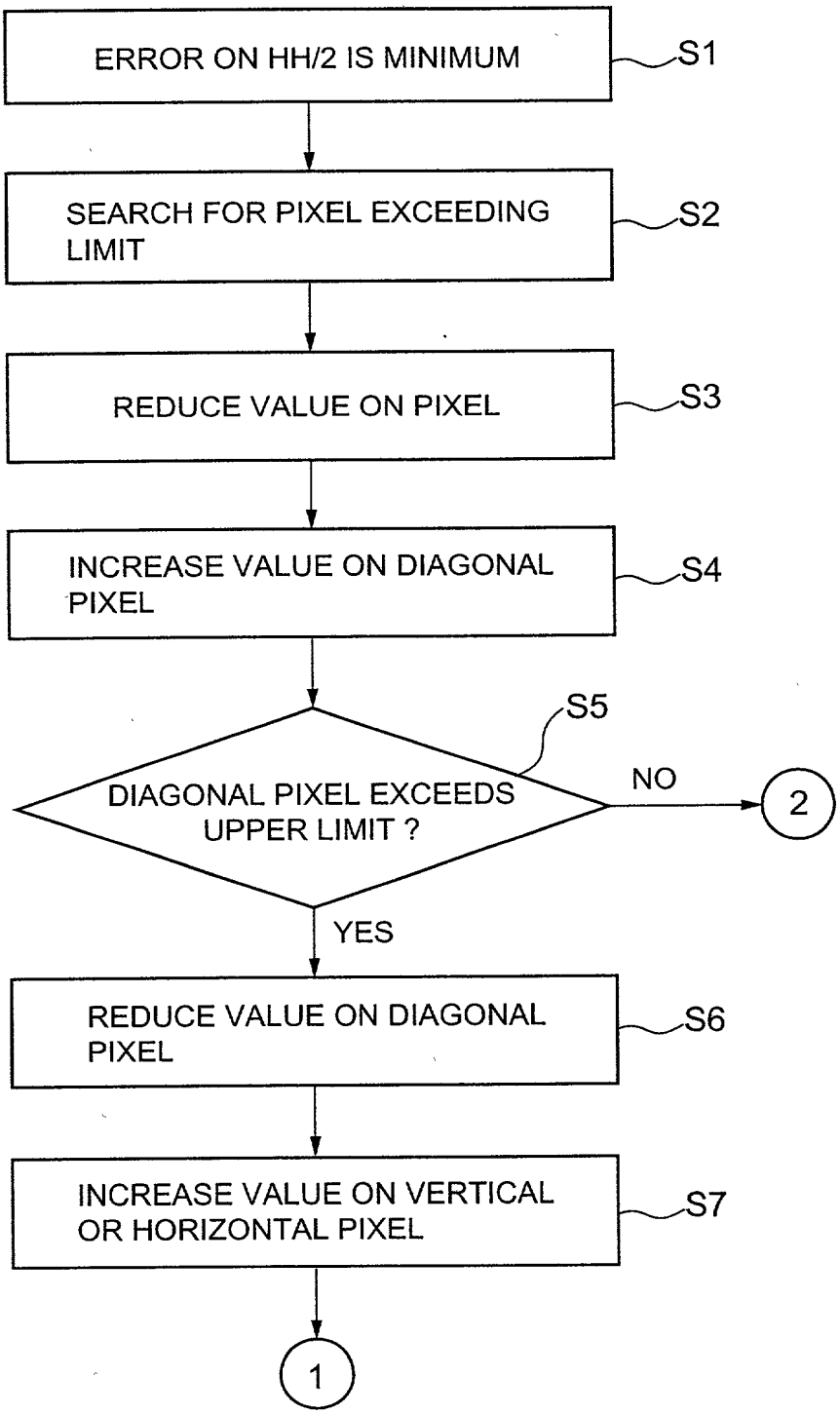
ERROR ON HH/2 IS MINIMUM
S1
SEARCH FOR PIXEL EXCEEDING LIMIT
S2
REDUCE VALUE ON PIXEL
S3
INCREASE VALUE ON DIAGONAL PIXEL
S4
S5
DIAGONAL PIXEL EXCEEDS UPPER LIMIT ?
NO
2
YES
REDUCE VALUE ON DIAGONAL PIXEL
S6
INCREASE VALUE ON VERTICAL OR HORIZONTAL PIXEL
S7
1

FIG.5B

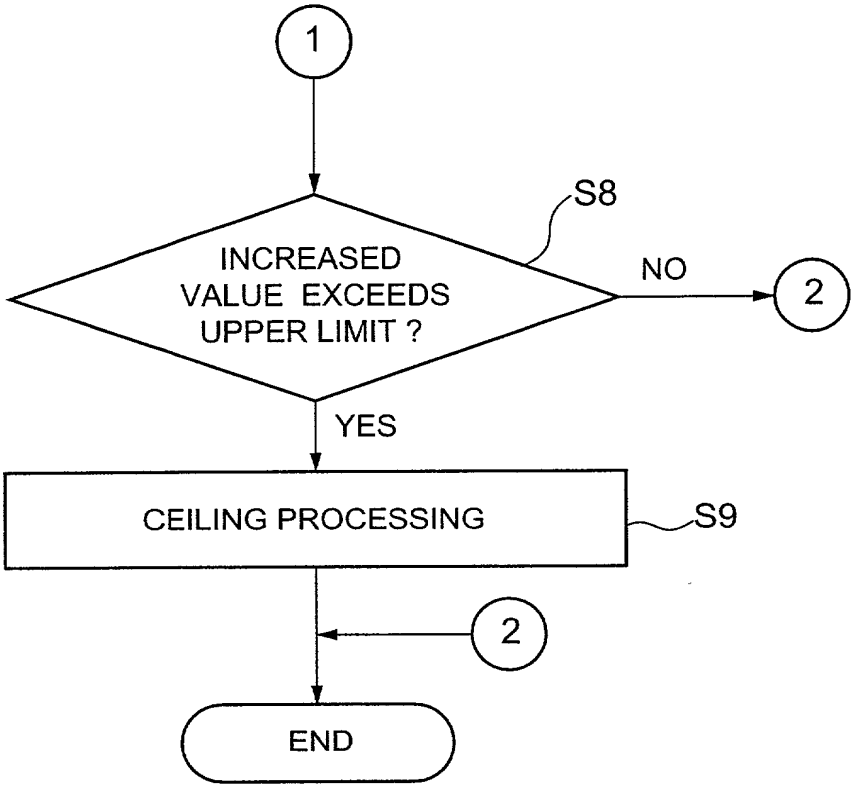
1
S8
INCREASED VALUE EXCEEDS UPPER LIMIT ?
NO
2
YES
CEILING PROCESSING
S9
2
END

FIG.6A

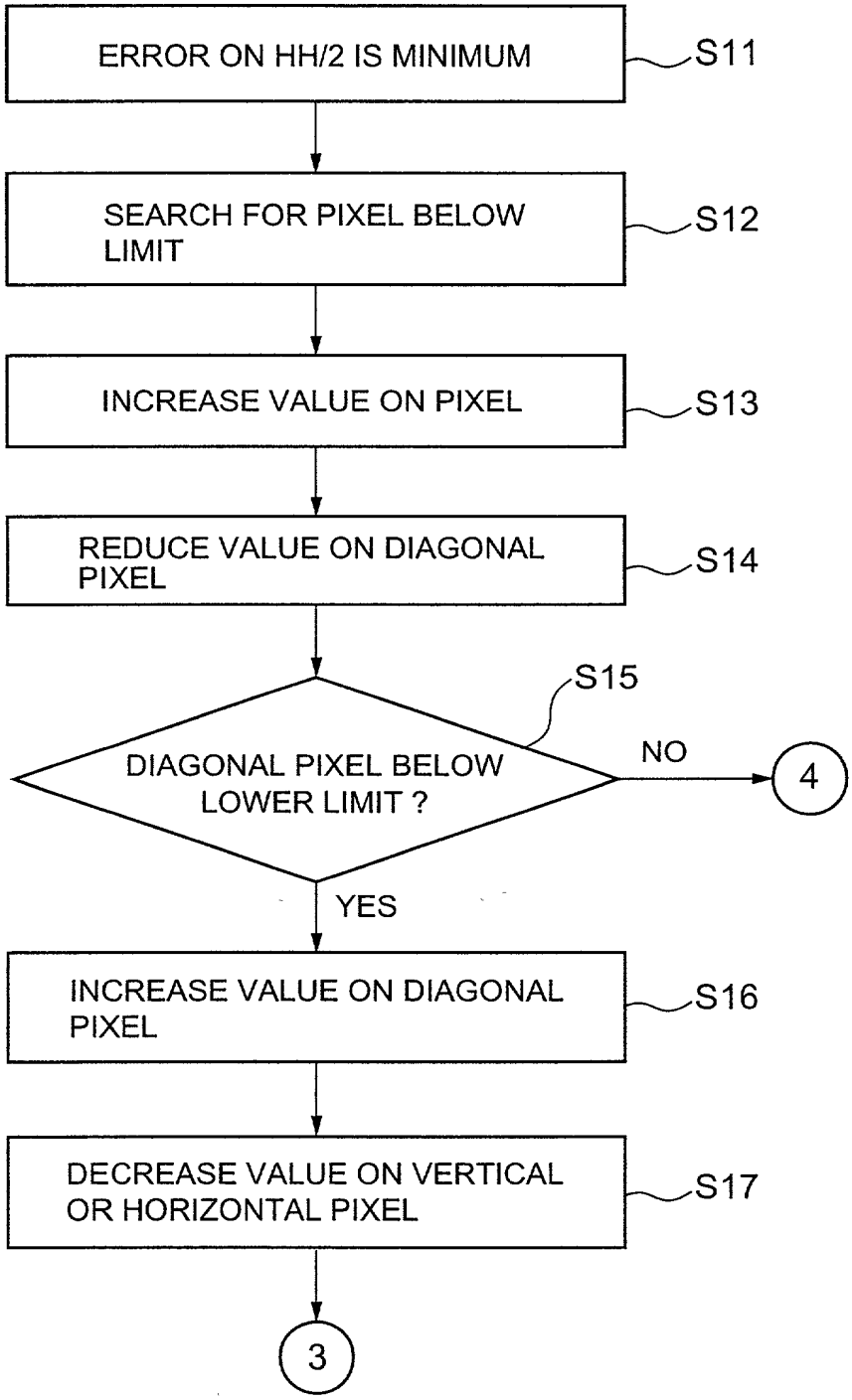
ERROR ON HH/2 IS MINIMUM
S11
SEARCH FOR PIXEL BELOW LIMIT
S12
INCREASE VALUE ON PIXEL
S13
REDUCE VALUE ON DIAGONAL PIXEL
S14
S15
DIAGONAL PIXEL BELOW LOWER LIMIT ?
NO
4
YES
INCREASE VALUE ON DIAGONAL PIXEL
S16
DECREASE VALUE ON VERTICAL OR HORIZONTAL PIXEL
S17
3

FIG.6B

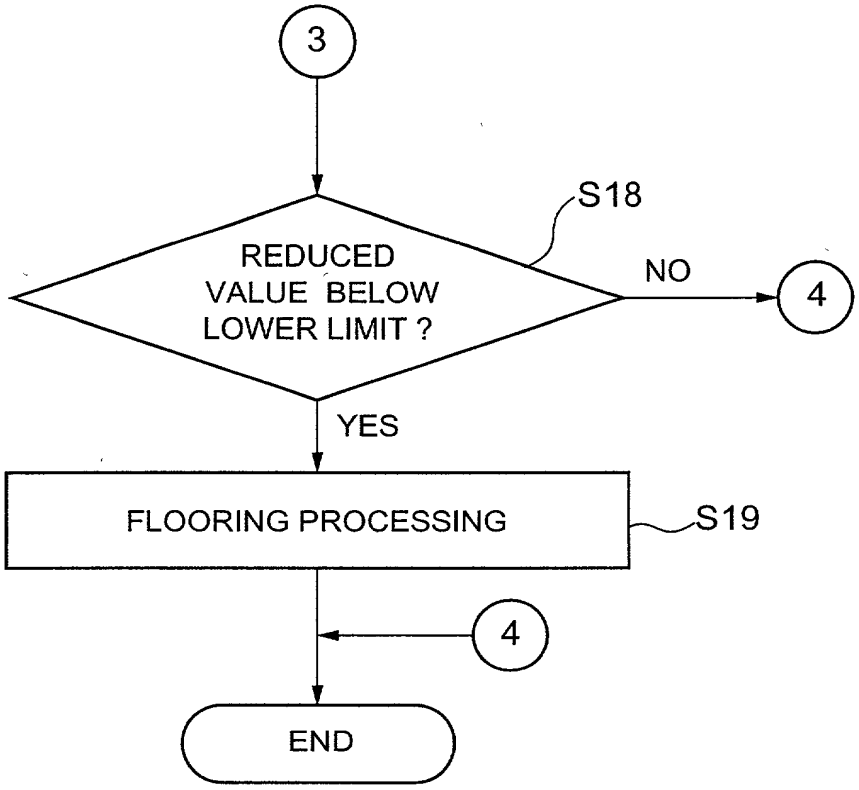
3
S18
REDUCED VALUE BELOW LOWER LIMIT ?
NO
4
YES
FLOORING PROCESSING
S19
4
END

FIG.7

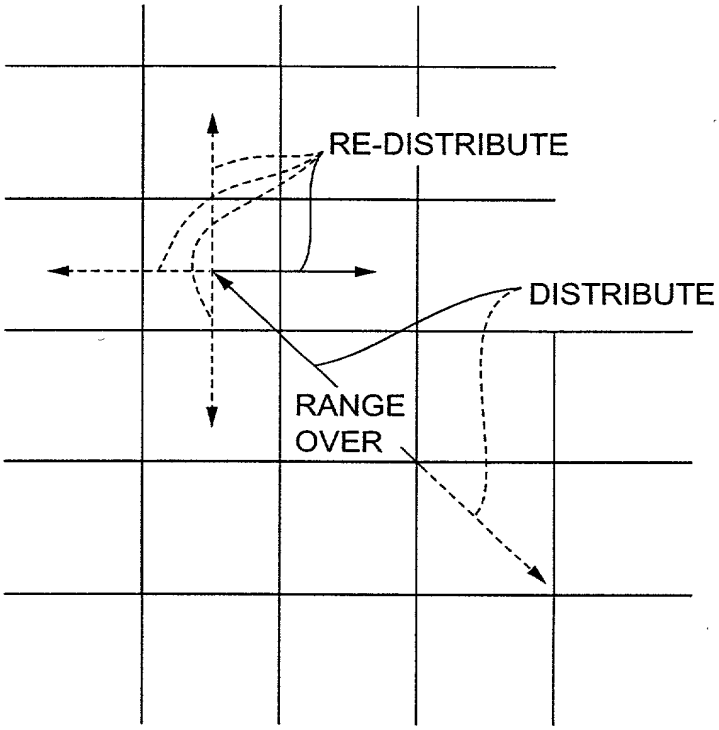

FIG. 8

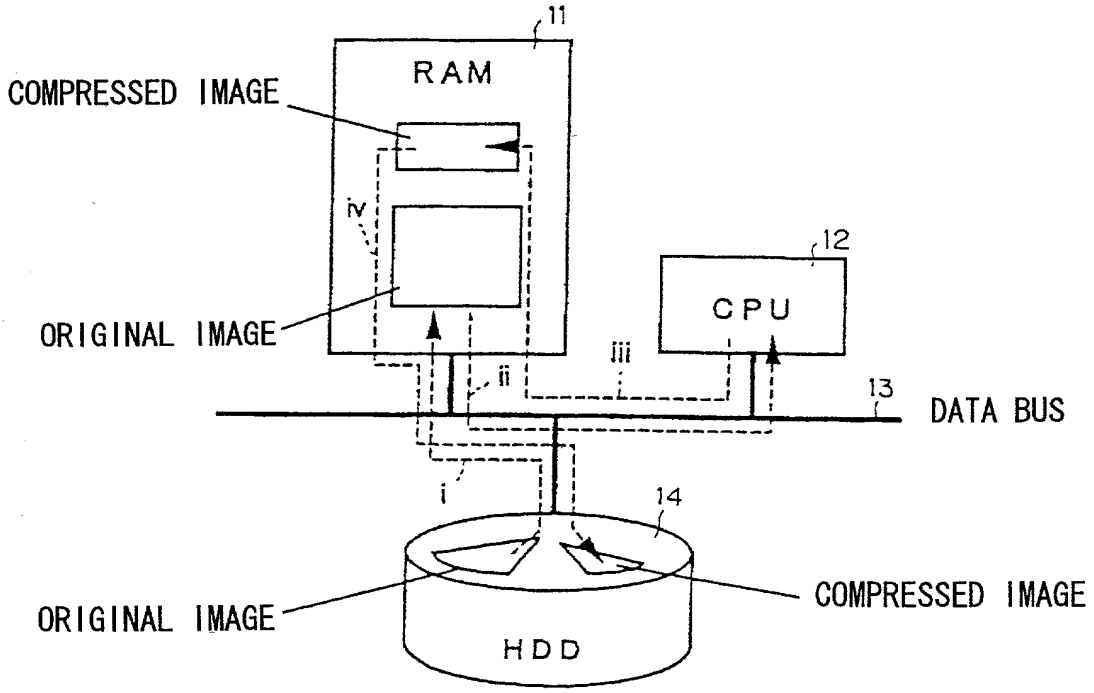
11
RAM
COMPRESSED IMAGE
iv
ORIGINAL IMAGE
12
CPU
iii
ii
13
DATA BUS
i
14
ORIGINAL IMAGE
COMPRESSED IMAGE
HDD

FIG. 9

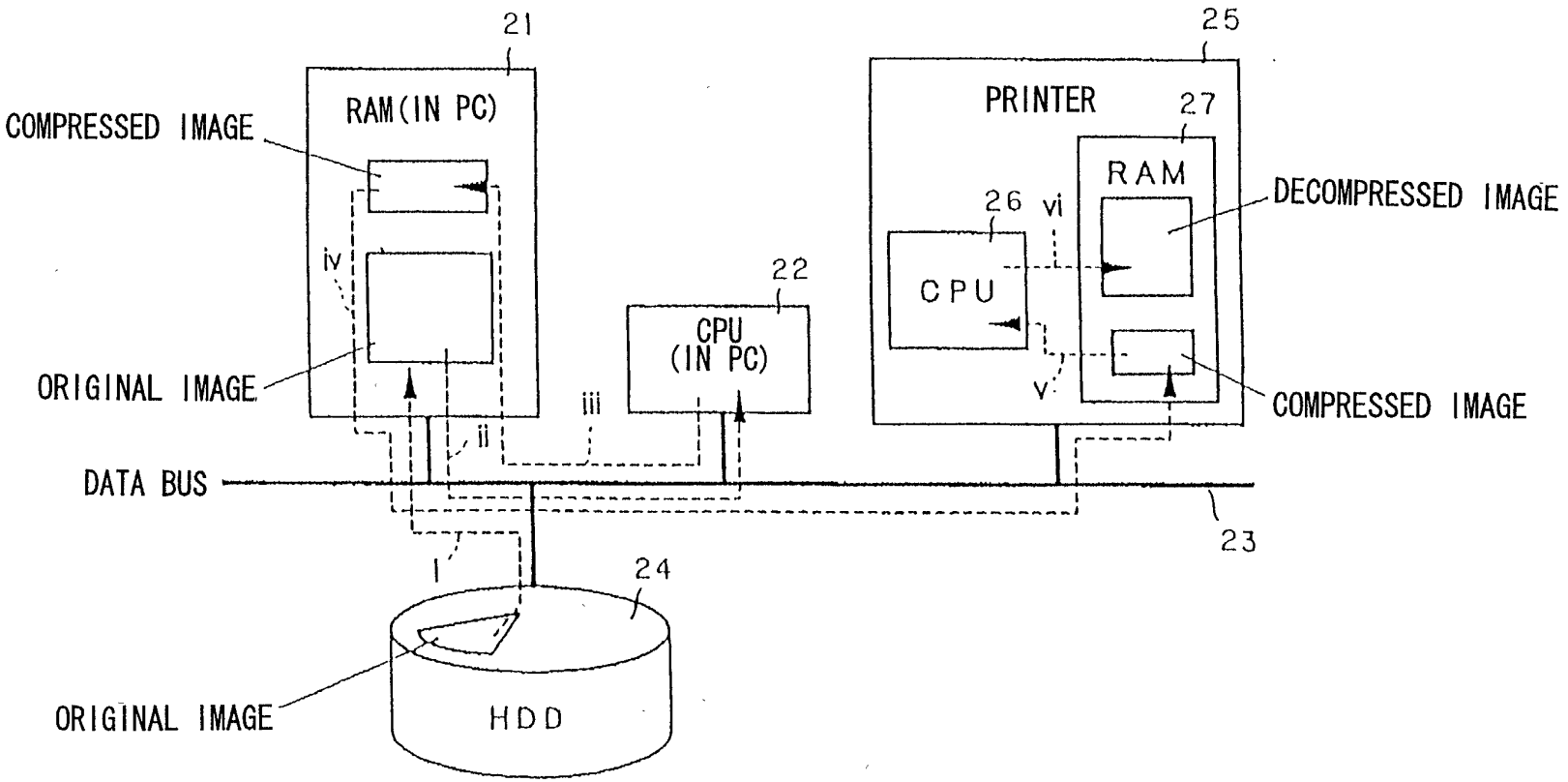

FIG.10

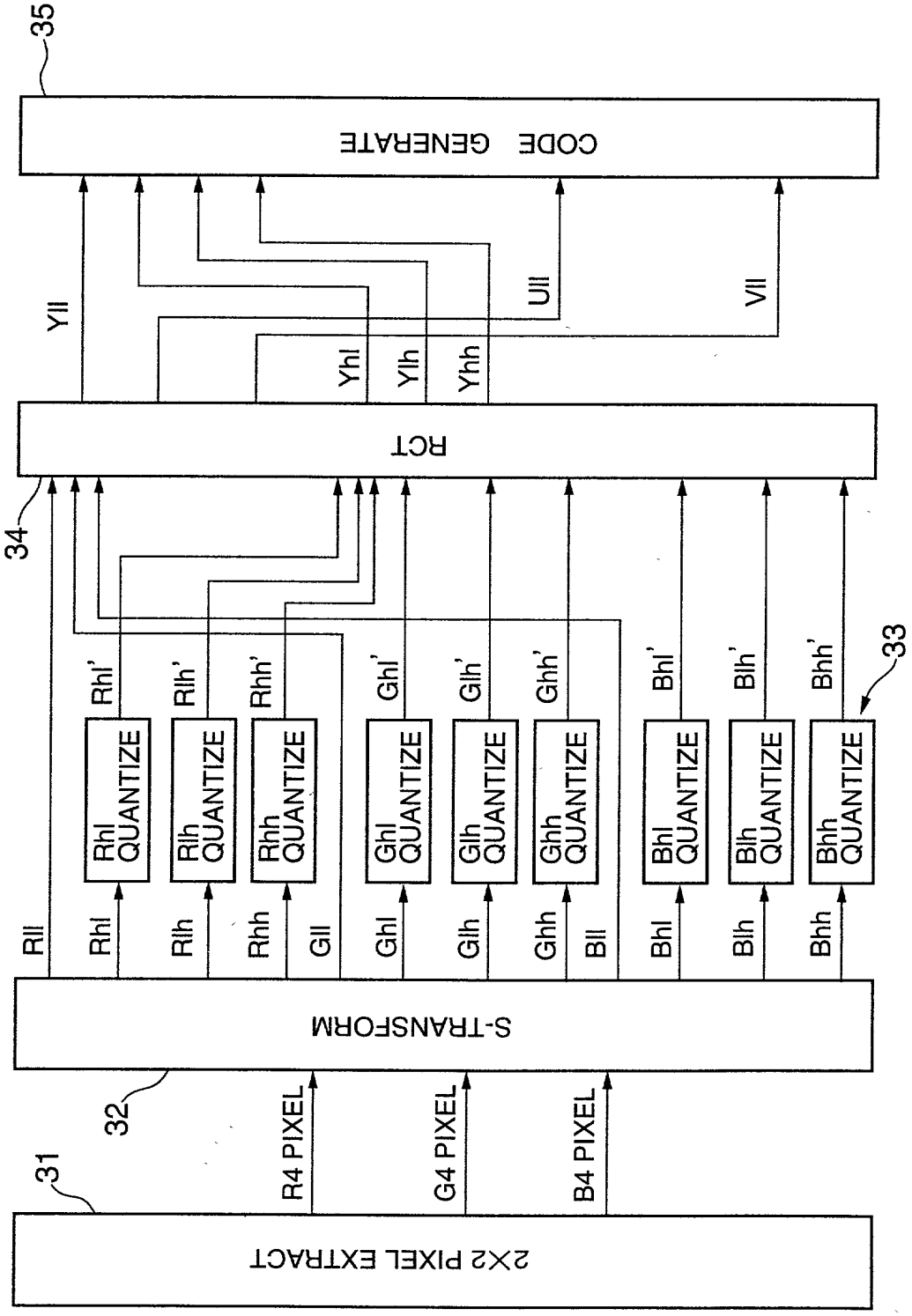
2×2 PIXEL EXTRACT
31
R4 PIXEL
G4 PIXEL
B4 PIXEL
32
S-TRANSFORM
RII
RhI
RIh
Rhh
GII
GhI
GIh
Ghh
BII
BhI
BIh
Bhh
RhI QUANTIZE
RIh QUANTIZE
Rhh QUANTIZE
GhI QUANTIZE
GIh QUANTIZE
Ghh QUANTIZE
BhI QUANTIZE
BIh QUANTIZE
Bhh QUANTIZE
RhI'
RIh'
Rhh'
GhI'
GIh'
Ghh'
BhI'
BIh'
Bhh'
33
34
RCT
YII
YhI
YIh
Yhh
UII
VII
35
CODE GENERATE

FIG. 11

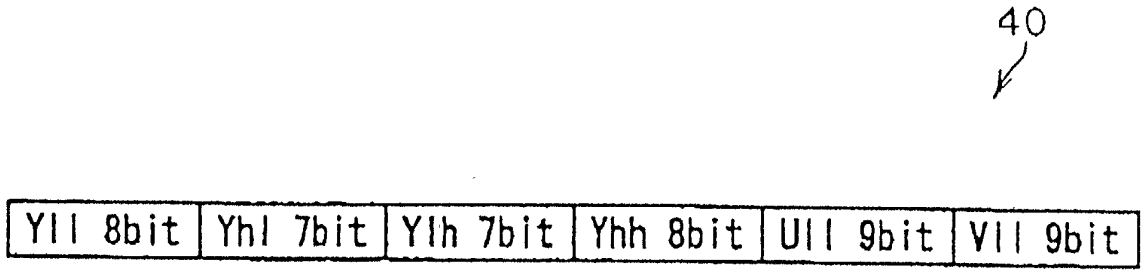

FIG.12

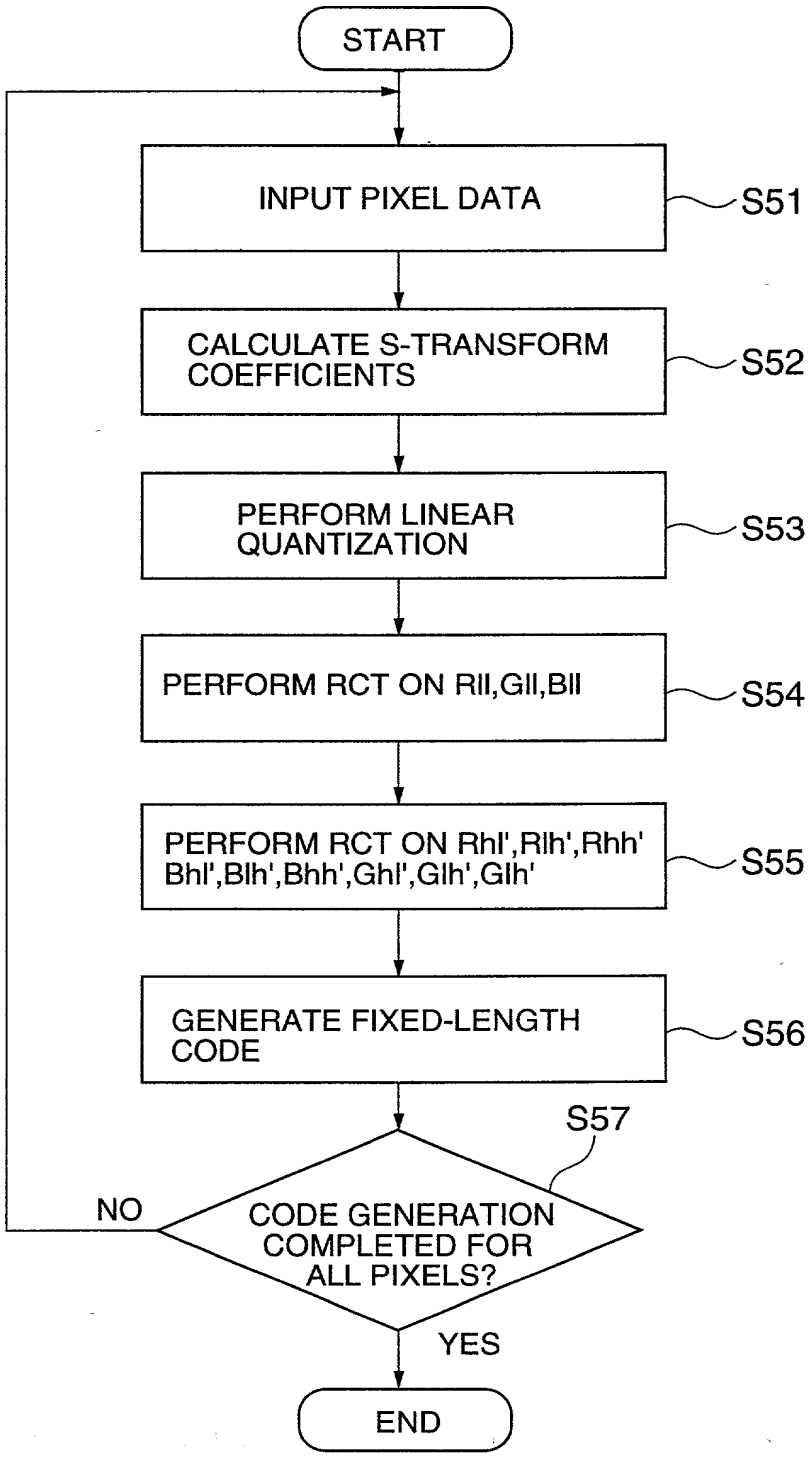
START
INPUT PIXEL DATA
S51
CALCULATE S-TRANSFORM COEFFICIENTS
S52
PERFORM LINEAR QUANTIZATION
S53
PERFORM RCT ON RII,GII,BII
S54
PERFORM RCT ON RhI',RIh',Rhh' BhI',BIh',Bhh',GhI',GIh',GIh'
S55
GENERATE FIXED-LENGTH CODE
S56
S57
CODE GENERATION COMPLETED FOR ALL PIXELS?
NO
YES
END

FIG.13

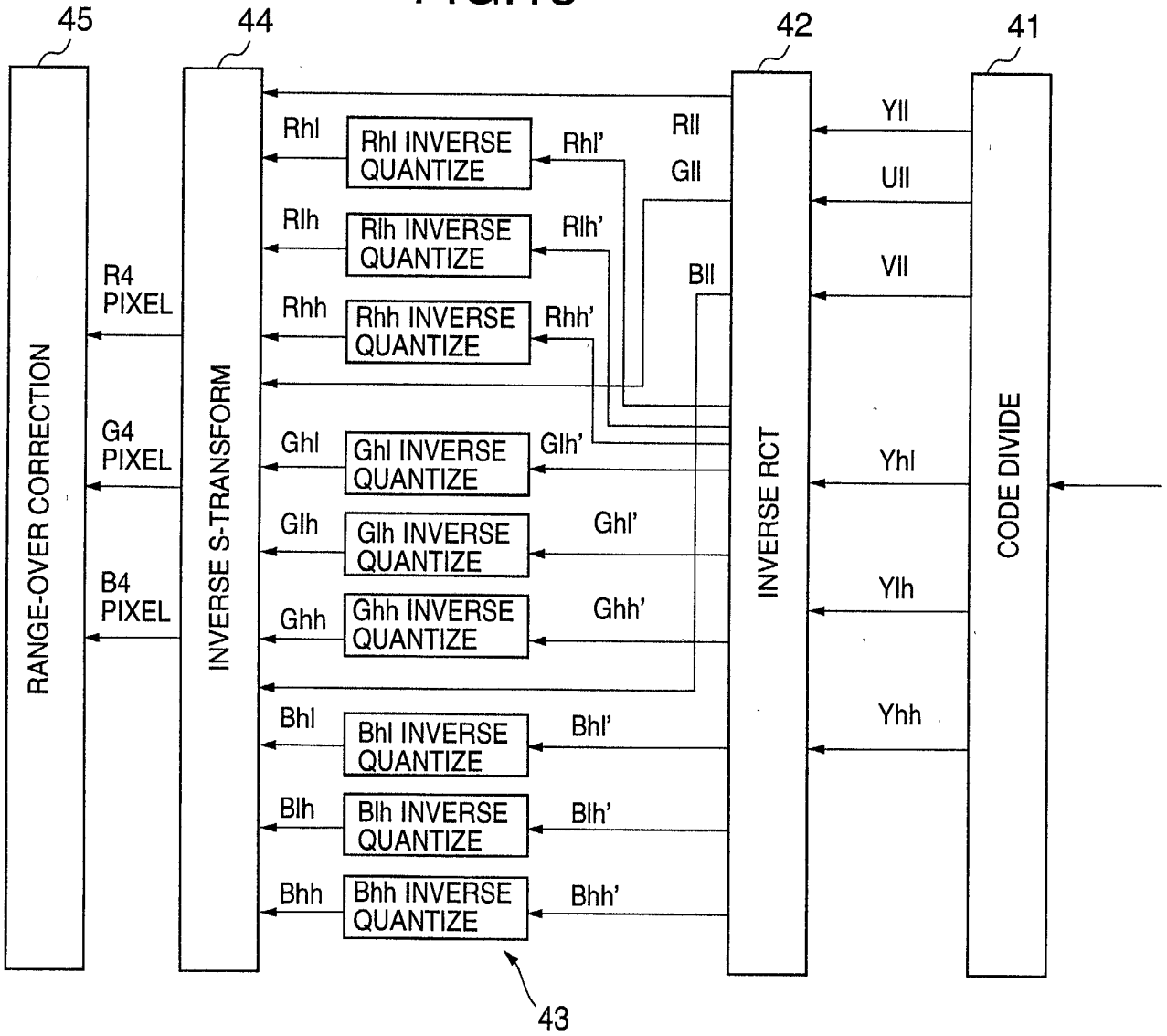
45
44
42
41
RANGE-OVER CORRECTION
INVERSE S-TRANSFORM
INVERSE RCT
CODE DIVIDE
R4 PIXEL
G4 PIXEL
B4 PIXEL
Rhl
Rhl INVERSE QUANTIZE
Rhl'
Rlh
Rlh INVERSE QUANTIZE
Rlh'
Rhh
Rhh INVERSE QUANTIZE
Rhh'
Ghl
Ghl INVERSE QUANTIZE
Glh'
Glh
Glh INVERSE QUANTIZE
Ghl'
Ghh
Ghh INVERSE QUANTIZE
Ghh'
Bhl
Bhl INVERSE QUANTIZE
Bhl'
Blh
Blh INVERSE QUANTIZE
Blh'
Bhh
Bhh INVERSE QUANTIZE
Bhh'
Rll
Gll
Bll
Yll
Ull
Vll
Yhl
Ylh
Yhh
43

FIG.14

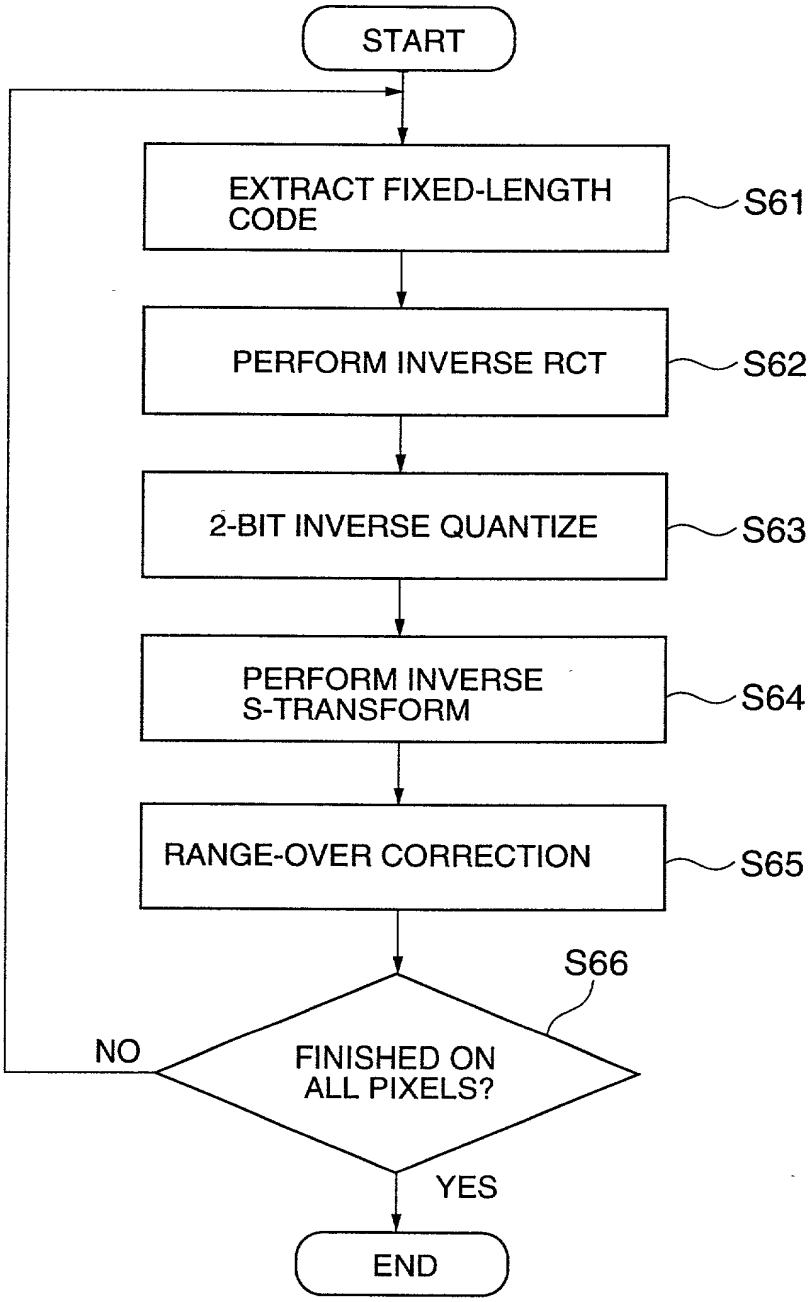
START
EXTRACT FIXED-LENGTH CODE
S61
PERFORM INVERSE RCT
S62
2-BIT INVERSE QUANTIZE
S63
PERFORM INVERSE S-TRANSFORM
S64
RANGE-OVER CORRECTION
S65
S66
FINISHED ON ALL PIXELS?
NO
YES
END

FIG.15

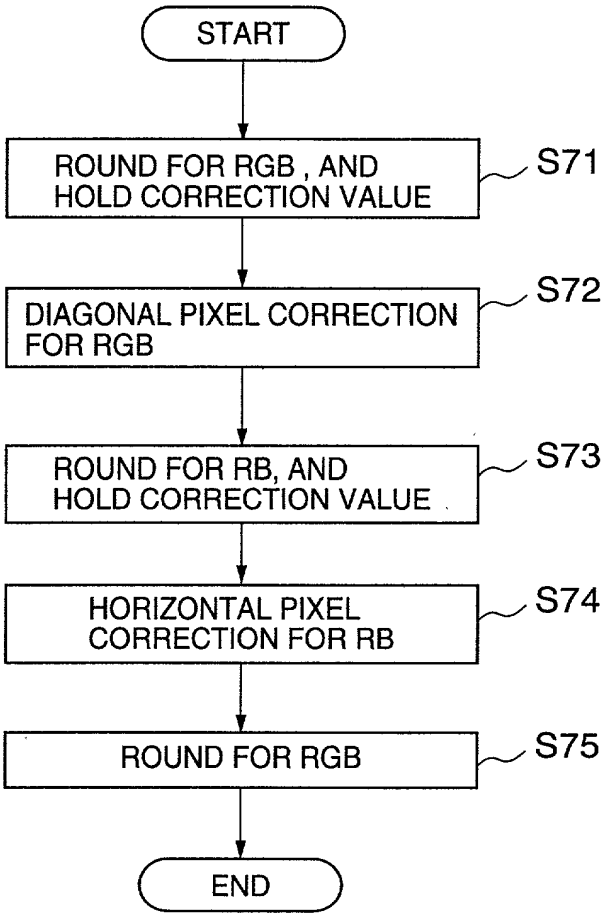
START
ROUND FOR RGB , AND HOLD CORRECTION VALUE
S71
DIAGONAL PIXEL CORRECTION FOR RGB
S72
ROUND FOR RB, AND HOLD CORRECTION VALUE
S73
HORIZONTAL PIXEL CORRECTION FOR RB
S74
ROUND FOR RGB
S75
END

FIG.16

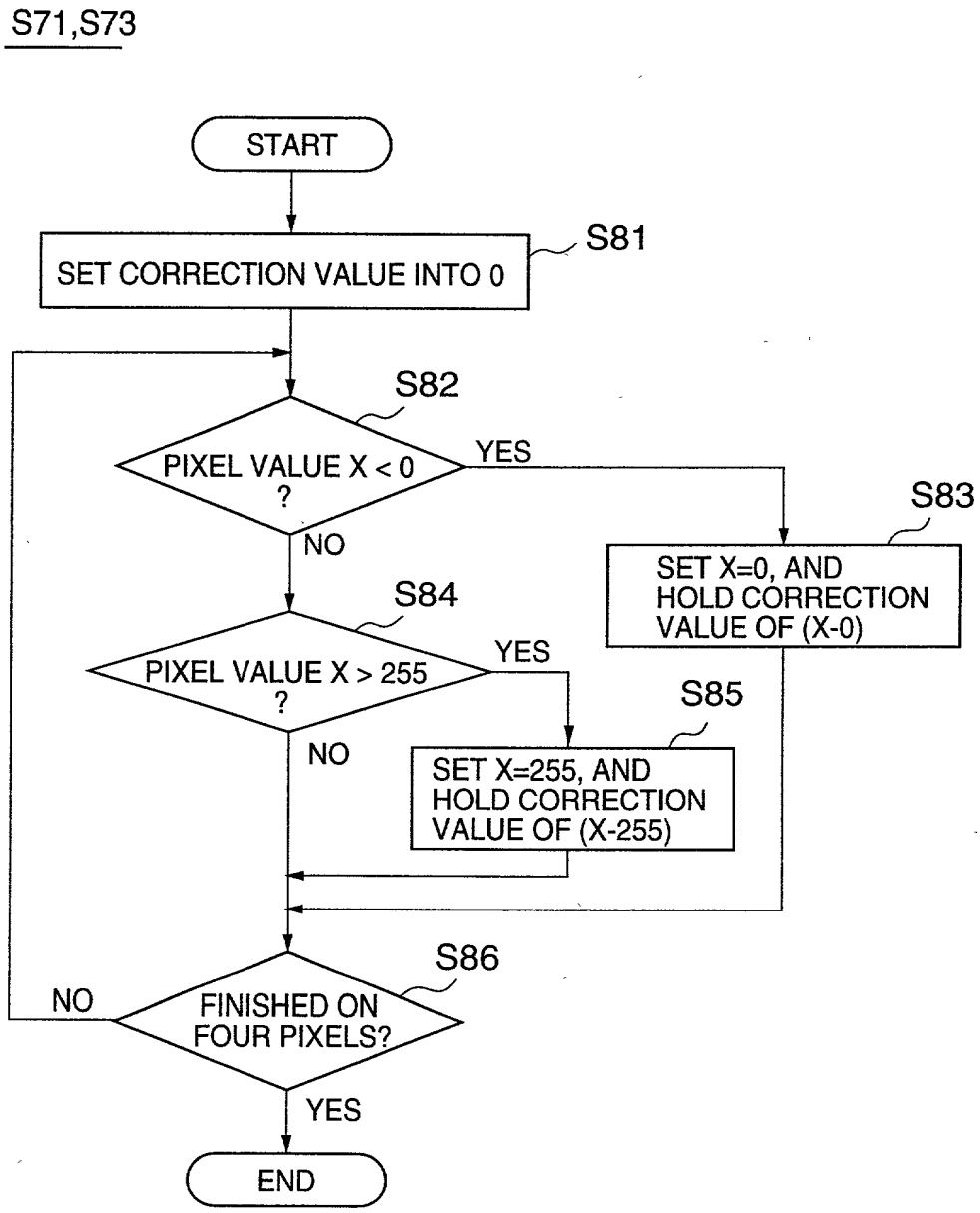
S71,S73
START
SET CORRECTION VALUE INTO 0
S81
S82
PIXEL VALUE X < 0 ?
YES
NO
S83
SET X=0, AND HOLD CORRECTION VALUE OF (X-0)
S84
PIXEL VALUE X > 255 ?
YES
NO
S85
SET X=255, AND HOLD CORRECTION VALUE OF (X-255)
S86
FINISHED ON FOUR PIXELS?
NO
YES
END

FIG.17

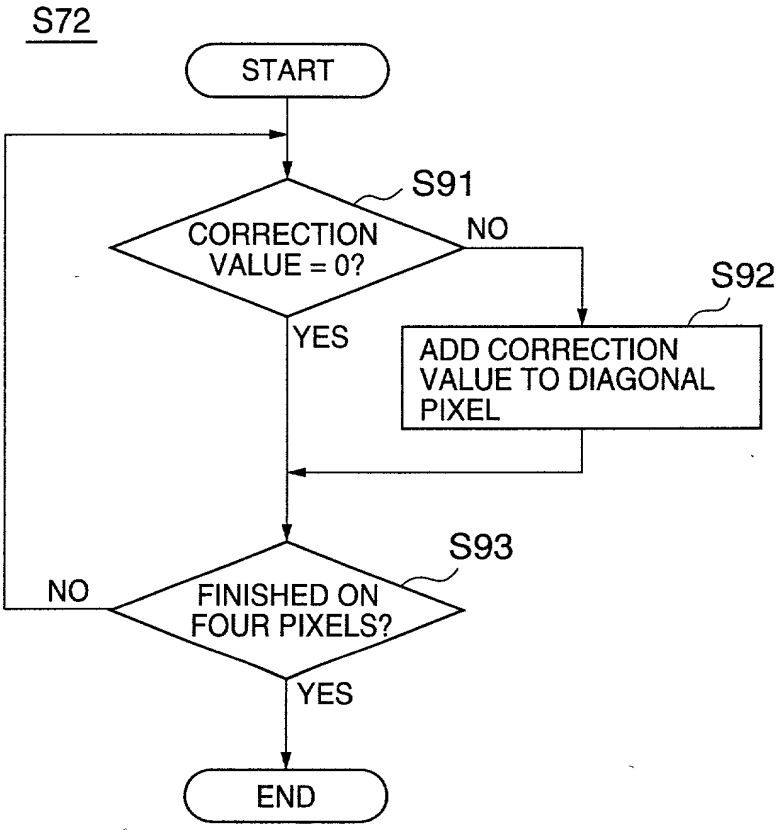
S72
START
S91
CORRECTION VALUE = 0?
NO
YES
S92
ADD CORRECTION VALUE TO DIAGONAL PIXEL
S93
FINISHED ON FOUR PIXELS?
NO
YES
END

FIG.18

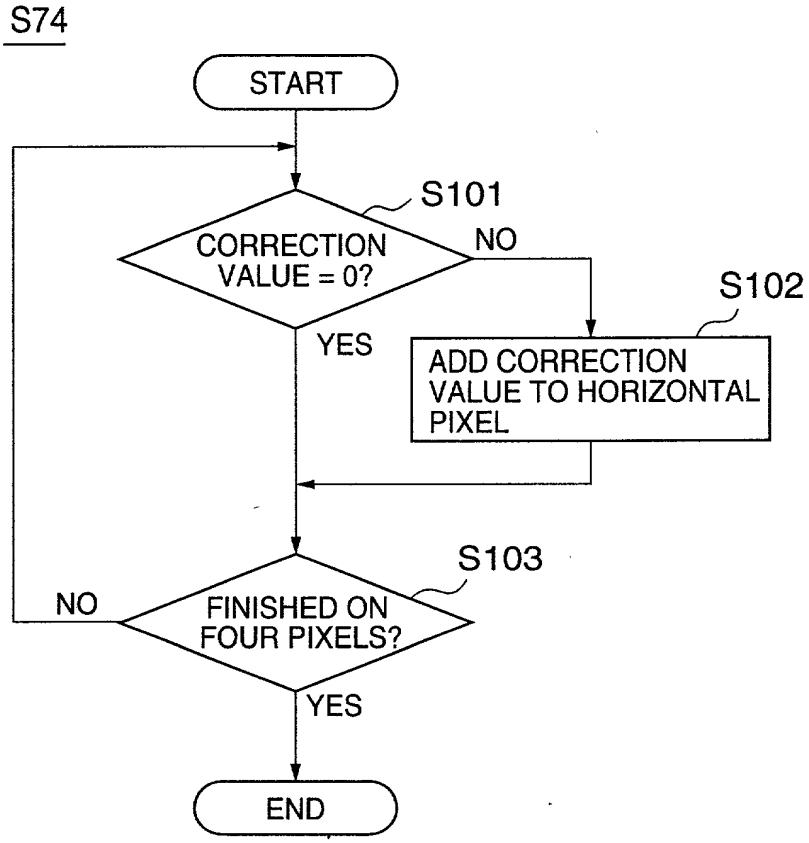
S74
START
S101
CORRECTION VALUE = 0?
NO
YES
S102
ADD CORRECTION VALUE TO HORIZONTAL PIXEL
S103
NO
FINISHED ON FOUR PIXELS?
YES
END

FIG.19

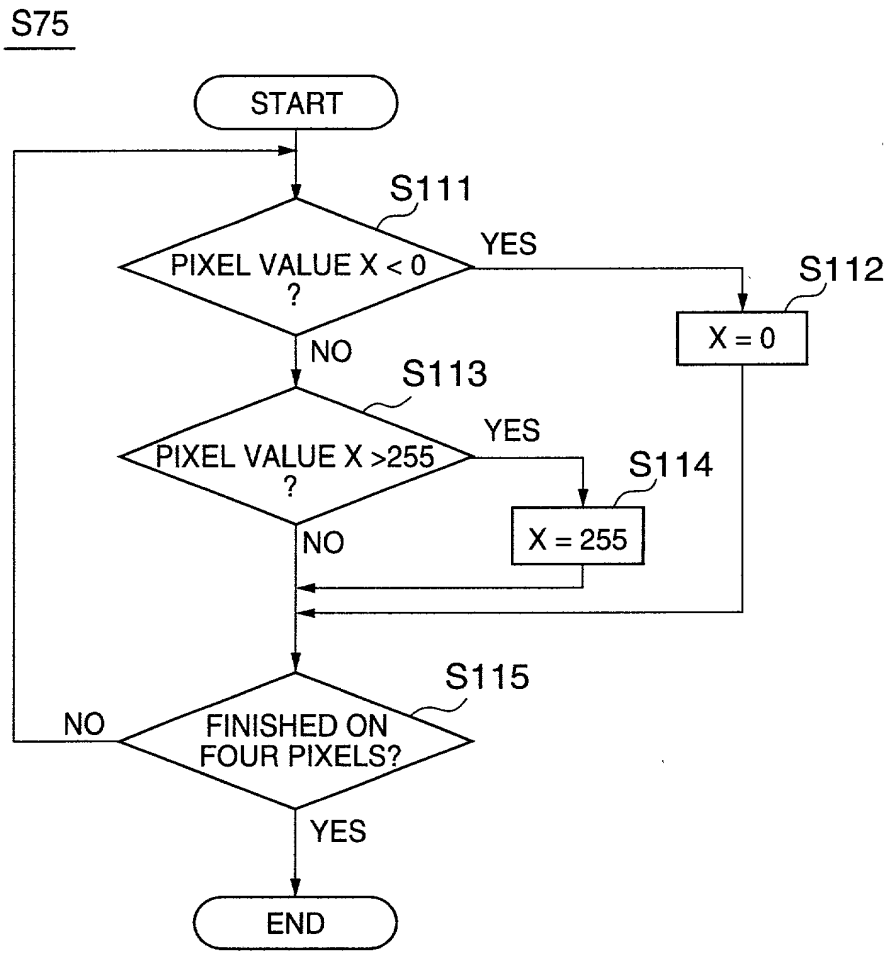
S75
START
S111
PIXEL VALUE X < 0 ?
YES
S112
X = 0
NO
S113
PIXEL VALUE X >255 ?
YES
S114
X = 255
NO
S115
NO
FINISHED ON FOUR PIXELS?
YES
END

FIG.20

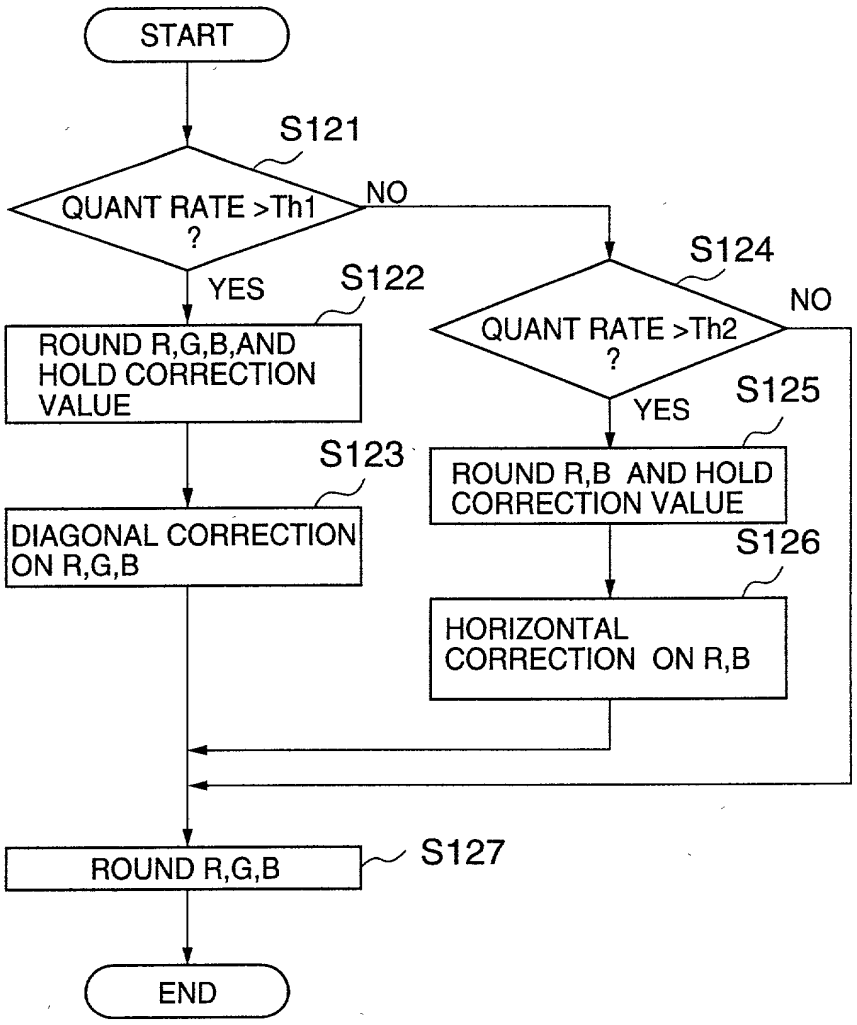
START
S121
QUANT RATE >Th1 ?
NO
YES
S122
ROUND R,G,B,AND HOLD CORRECTION VALUE
S123
DIAGONAL CORRECTION ON R,G,B
S124
QUANT RATE >Th2 ?
NO
YES
S125
ROUND R,B AND HOLD CORRECTION VALUE
S126
HORIZONTAL CORRECTION ON R,B
ROUND R,G,B
S127
END

FIG. 21

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HEADER 2 bit	Yll 8bit	Yhl 7bit	Ylh 7bit	Yhh 8bit	Ull 9bit	Vll 9bit

FIG.22

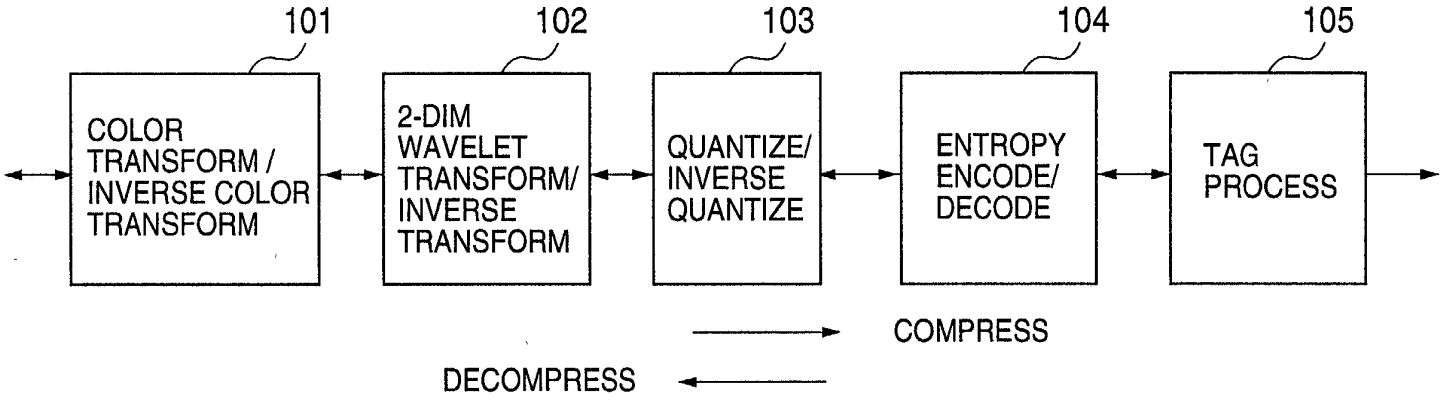
101
102
103
104
105
COLOR TRANSFORM / INVERSE COLOR TRANSFORM
2-DIM WAVELET TRANSFORM/ INVERSE TRANSFORM
QUANTIZE/ INVERSE QUANTIZE
ENTROPY ENCODE/ DECODE
TAG PROCESS
COMPRESS
DECOMPRESS

FIG. 23

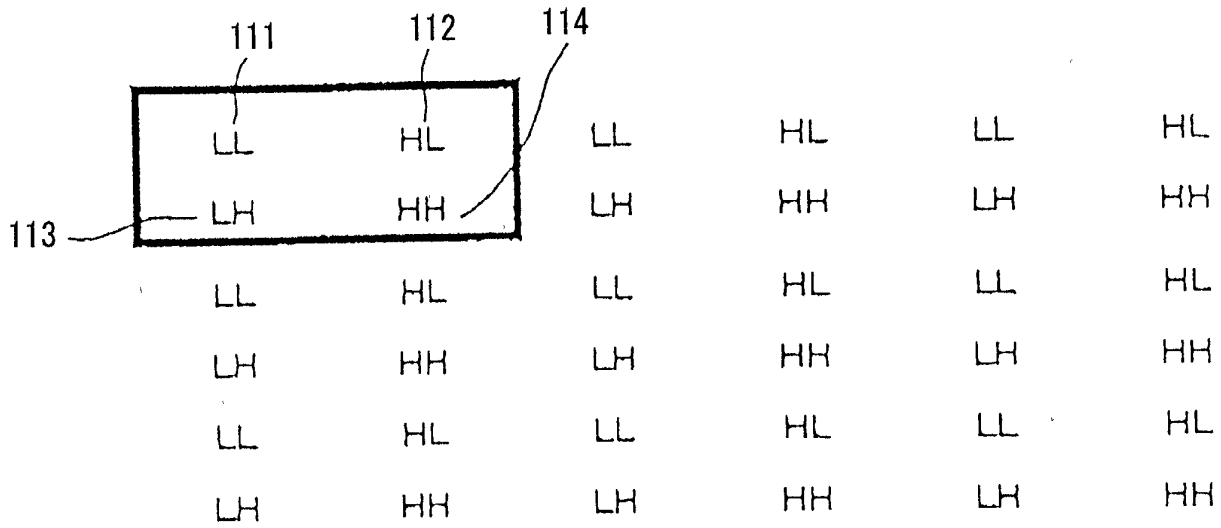

FIG. 24A

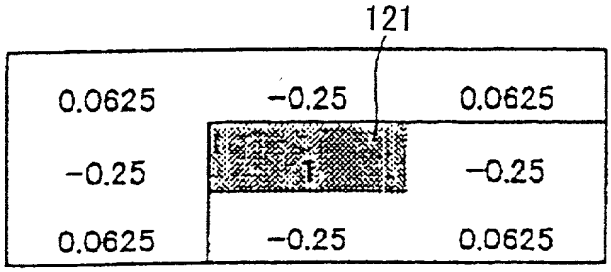

FIG. 24B

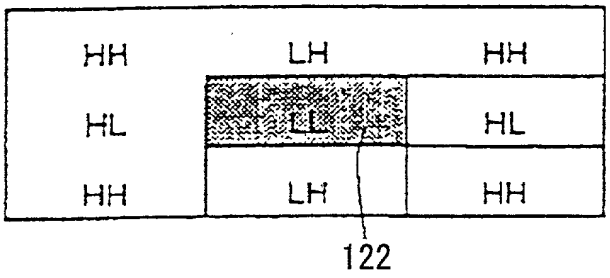

FIG. 25A

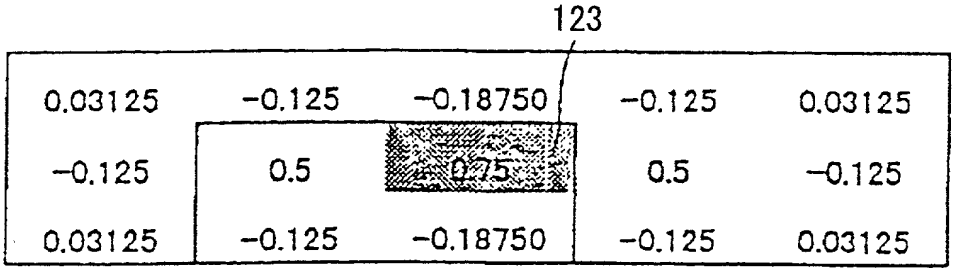

FIG. 25B

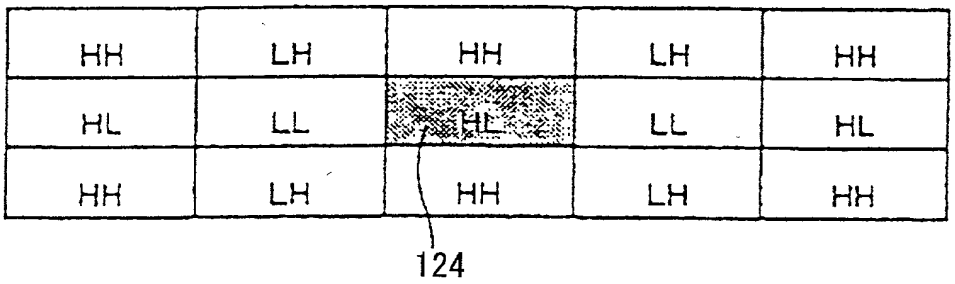

FIG. 26A

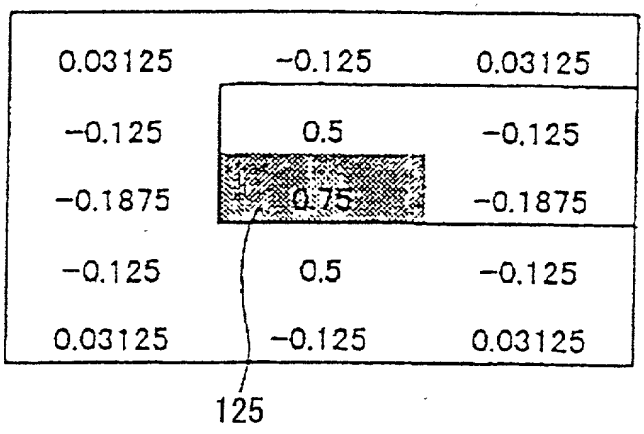

FIG. 26B

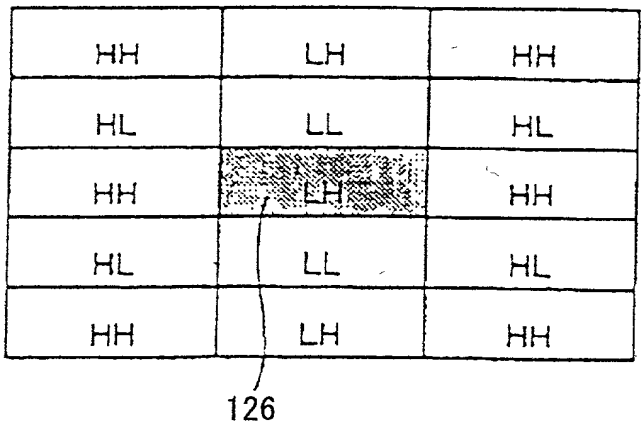

FIG. 27A

0.015625	−0.0625	−0.09375	−0.0625	0.015625
−0.06250	0.25	0.375	0.25	−0.06250
−0.09375	0.375	0.5625	0.375	−0.09375
−0.06250	0.25	0.375	0.25	−0.06250
0.015625	−0.0625	−0.09375	−0.0625	0.015625

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FIG. 27B

HH	LH	HH	LH	HH
HL	LL	HL	LL	HL
HH	LH	HH	LH	HH
HL	LL	HL	LL	HL
HH	LH	HH	LH	HH

128

FIG. 28A

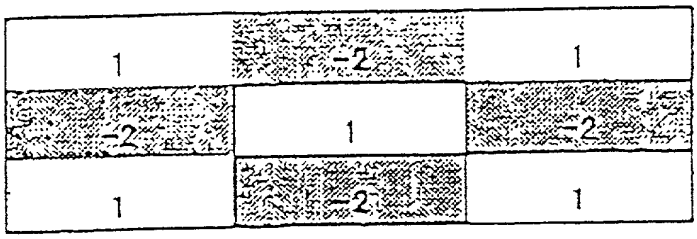

FIG. 28B

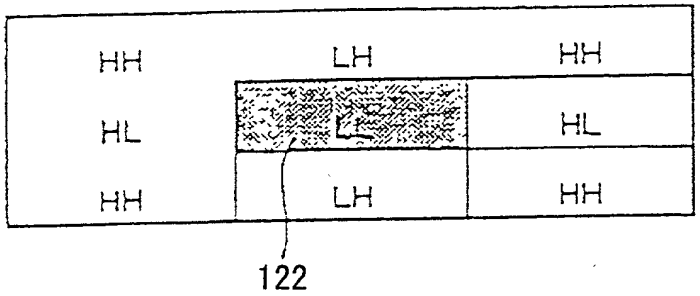

FIG. 29A

0.5	−1	−3	−1	0.5
−1	0.5	6	0.5	−1
0.5	−1	−3	−1	0.5

FIG. 29B

HH	LH	HH	LH	HH
HL	LL	HL	LL	HL
HH	LH	HH	LH	HH

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FIG. 30A

0.5	−1	0.5
−1	0.5	−1
−3	6	−3
−1	0.5	−1
0.5	−1	0.5

FIG. 30B

HH	LH	HH
HL	LL	HL
HH	LH	HH
HL	LL	HL
HH	LH	HH

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FIG. 31A

0.3	−0.5	−1.5	−0.5	0.3
−0.5	0.3	3.0	0.3	−0.5
−1.5	3.0	9.0	3.0	−1.5
−0.5	0.3	3.0	0.3	−0.5
0.3	−0.5	−1.5	−0.5	0.3

FIG. 31B

HH	LH	HH	LH	HH
HL	LL	HL	LL	HL
HH	LH	HH	LH	HH
HL	LL	HL	LL	HL
HH	LH	HH	LH	HH

128

FIG.32

RANGE-OVER PIXEL	PIXEL TO BEAR RANGE-OVER
LL POSITION	HL OR LH POSITION
HL POSITION	LL ,AND THEN,LH POSITION
LH POSITION	LL ,AND THEN,HL POSITION
HH POSITION	HL OR LH POSITION

FIG.33

	LL POSITION	HL POSITION	LH POSITION	HH POSITION
CONTRIBUTION TO LL POSITION	1.00	−0.25	−0.25	0.06
CONTRIBUTION TO HL POSITION	0.50	0.75	−0.13	−0.19
CONTRIBUTION TO LH POSITION	0.50	−0.13	0.75	−0.19
CONTRIBUTION TO HH POSITION	0.25	0.38	0.38	0.56

FIG. 34

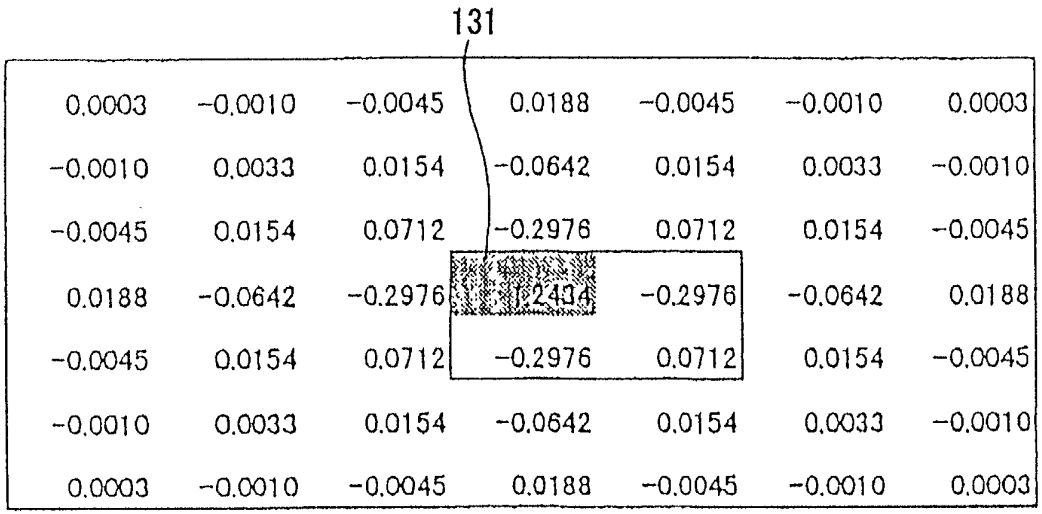
131
0.0003 -0.0010 -0.0045 0.0188 -0.0045 -0.0010 0.0003
-0.0010 0.0033 0.0154 -0.0642 0.0154 0.0033 -0.0010
-0.0045 0.0154 0.0712 -0.2976 0.0712 0.0154 -0.0045
0.0188 -0.0642 -0.2976 1.2454 -0.2976 -0.0642 0.0188
-0.0045 0.0154 0.0712 -0.2976 0.0712 0.0154 -0.0045
-0.0010 0.0033 0.0154 -0.0642 0.0154 0.0033 -0.0010
0.0003 -0.0010 -0.0045 0.0188 -0.0045 -0.0010 0.0003

FIG. 35

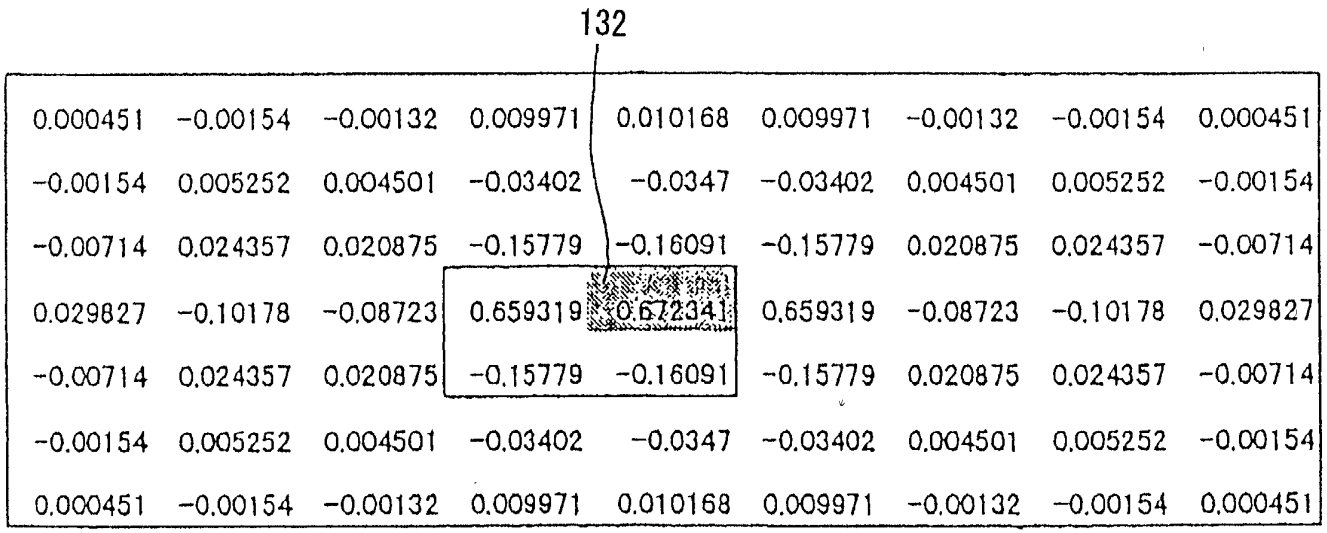
132
0.000451 -0.00154 -0.00132 0.009971 0.010168 0.009971 -0.00132 -0.00154 0.000451
-0.00154 0.005252 0.004501 -0.03402 -0.0347 -0.03402 0.004501 0.005252 -0.00154
-0.00714 0.024357 0.020875 -0.15779 -0.16091 -0.15779 0.020875 0.024357 -0.00714
0.029827 -0.10178 -0.08723 0.659319 0.672341 0.659319 -0.08723 -0.10178 0.029827
-0.00714 0.024357 0.020875 -0.15779 -0.16091 -0.15779 0.020875 0.024357 -0.00714
-0.00154 0.005252 0.004501 -0.03402 -0.0347 -0.03402 0.004501 0.005252 -0.00154
0.000451 -0.00154 -0.00132 0.009971 0.010168 0.009971 -0.00132 -0.00154 0.000451

FIG. 36

0.000451	-0.00154	-0.00714	0.029827	-0.00714	-0.00154	0.000451
-0.00154	0.005252	0.024357	-0.10178	0.024357	0.005252	-0.00154
-0.00132	0.004501	0.020875	-0.08723	0.020875	0.004501	-0.00132
0.009971	-0.03402	-0.15779	0.659319	-0.15779	-0.03402	0.009971
0.010168	-0.0347	-0.16091	0.672341	-0.16091	-0.0347	0.010168
0.009971	-0.03402	-0.15779	0.659319	-0.15779	-0.03402	0.009971
-0.00132	0.004501	0.020875	-0.08723	0.020875	0.004501	-0.00132
-0.00154	0.005252	0.024357	-0.10178	0.024357	0.005252	-0.00154
0.000451	-0.00154	-0.00714	0.029827	-0.00714	-0.00154	0.000451

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FIG. 37

0.000715	-0.00244	-0.00209	0.015816	0.016128	0.015816	-0.00209	-0.00244	0.000715
-0.00244	0.008331	0.00714	-0.05397	-0.05503	-0.05397	0.00714	0.008331	-0.00244
-0.00209	0.00714	0.006119	-0.04625	-0.04716	-0.04625	0.006119	0.00714	-0.00209
0.015816	-0.05397	-0.04625	0.349602	0.356507	0.349602	-0.04625	-0.05397	0.015816
0.016128	-0.05503	-0.0472	0.356507	0.360548	0.356507	-0.0472	-0.05503	0.016128
0.015816	-0.05397	-0.04625	0.349602	0.356507	0.349602	-0.04625	-0.05397	0.015816
-0.00209	0.00714	0.006119	-0.04625	-0.04716	-0.04625	0.006119	0.00714	-0.00209
-0.00244	0.008331	0.00714	-0.05397	-0.05503	-0.05397	0.00714	0.008331	-0.00244
0.000715	-0.00244	-0.00209	0.015816	0.016128	0.015816	-0.00209	-0.00244	0.000715

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FIG.38

	LL POSITION	HL POSITION	LH POSITION	HH POSITION
CONTRIBUTION TO LL POSITION	1.24	−2.38	−2.38	1.14
CONTRIBUTION TO HL POSITION	0.66	5.38	−1.26	−2.57
CONTRIBUTION TO LH POSITION	0.66	−1.26	5.38	−2.57
CONTRIBUTION TO HH POSITION	0.35	2.85	2.85	5.82

FIG.39

	LL POSITION	HL POSITION	LH POSITION	HH POSITION
CONTRIBUTION TO LL POSITION	1.24	−0.30	−0.30	0.07
CONTRIBUTION TO HL POSITION	0.66	0.67	−0.15	−0.16
CONTRIBUTION TO LH POSITION	0.66	−0.16	0.67	−2.57
CONTRIBUTION TO HH POSITION	0.35	0.36	0.36	0.36

FIG.40

RANGE-OVER PIXEL	PIXEL TO FIRST BEAR RANGE-OVER	PIXEL TO SECOND BEAR RANGE-OVER
LL POSITION	TO HL POSITION(HORIZONTAL)	TO LH POSITION(VERTICAL)
HL POSITION	TO LL POSITION(HORIZONTAL)	TO LH POSITION(DIAGONAL FROM HL)
LH POSITION	TO LL POSITION(VERTICAL)	TO LH POSITION(FOR SIMPLIFICATION)
HH POSITION	TO LH POSITION(HORIZONTAL)	TO LH POSITION(VERTICAL)

FIG. 41A

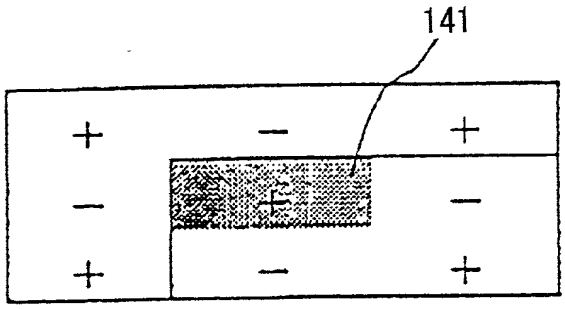


FIG. 41B

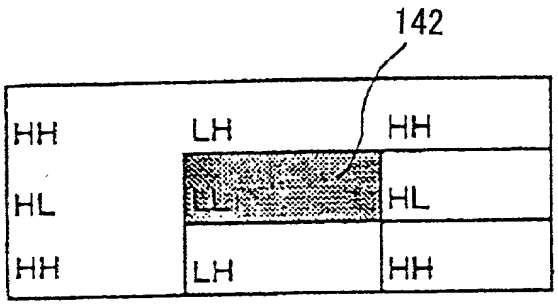


FIG. 42A

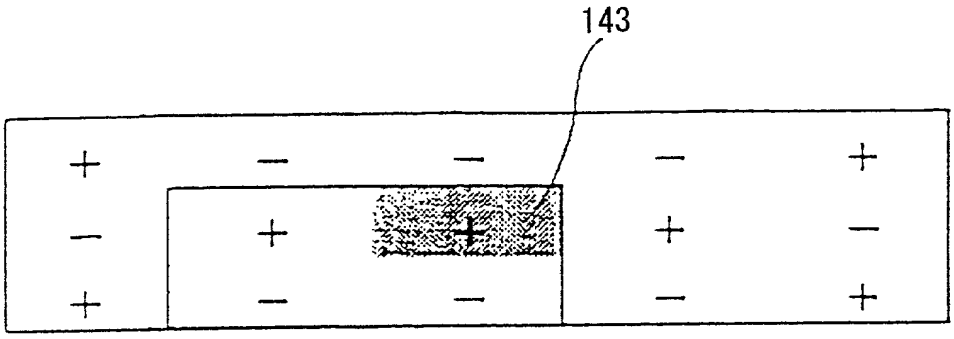


FIG. 42B

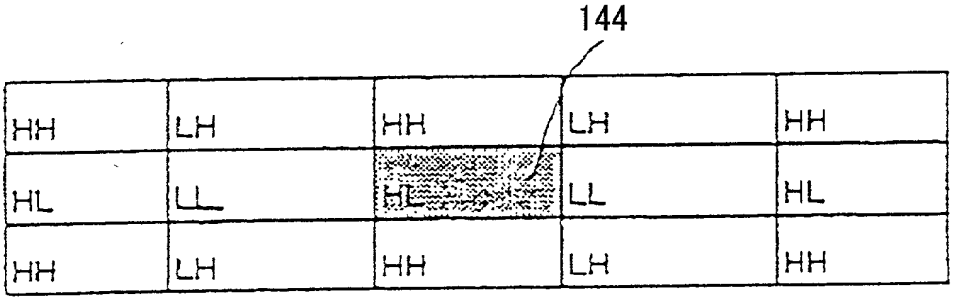


FIG. 43A

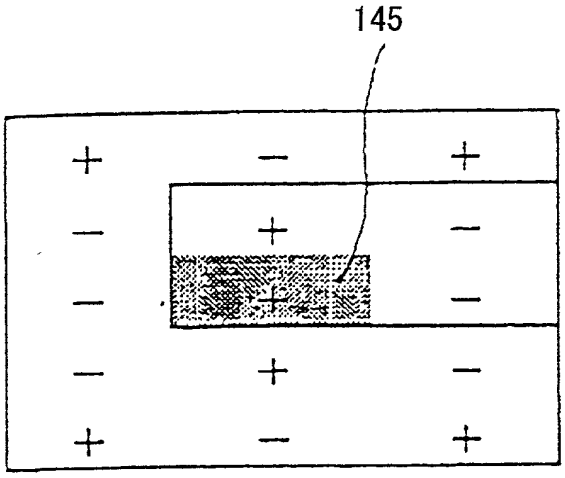


FIG. 43B

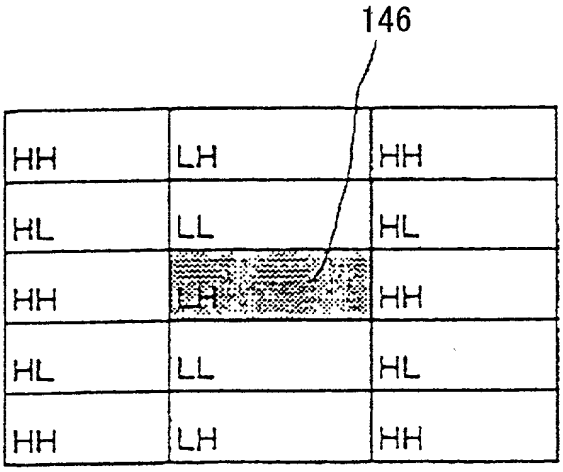


FIG. 44A

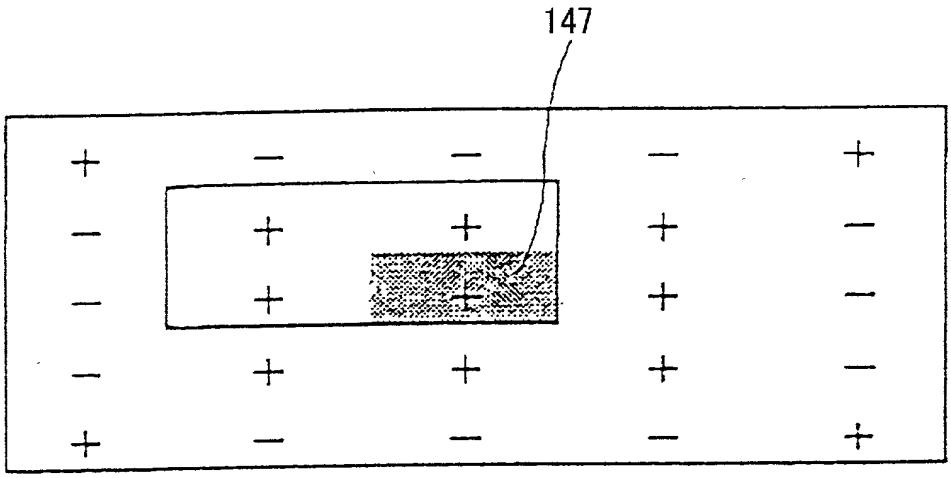


FIG. 44B

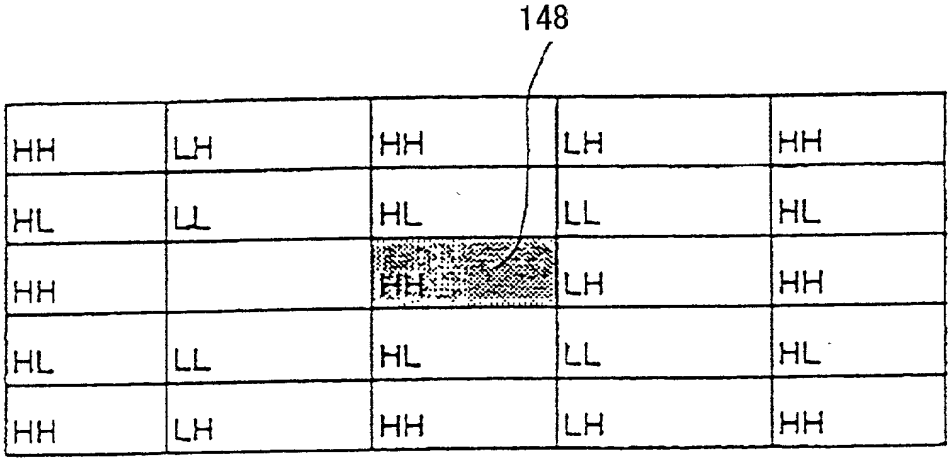


FIG.45

	LL POSITION	HL POSITION	LH POSITION	HH POSITION
CONTRIBUTION TO LL POSITION	+	−	−	+
CONTRIBUTION TO HL POSITION	+	+	−	−
CONTRIBUTION TO LH POSITION	+	−	+	−
CONTRIBUTION TO HH POSITION	+	+	+	+

FIG.46

RANGE-OVER PIXEL	FIRST DISTRIBUTION PLACE	SECOND DISTRIBUTION PLACE
LL POSITION	HH(DIAGONAL)	LH(VERTICAL)
HL POSITION	LH(DIAGONAL)	HH(VERTICAL)
LH POSITION	HL(DIAGONAL)	LL(VERTICAL)
HH POSITION	LL(DIAGONAL)	HL(VERTICAL)

FIG.47

RANGE-OVER PIXEL	FIRST DISTRIBUTION PLACE	SECOND DISTRIBUTION PLACE
LL POSITION	HH(DIAGONAL)	HL(HORIZONTAL)
HL POSITION	LH(DIAGONAL)	LL(HORIZONTAL)
LH POSITION	HL(DIAGONAL)	HH(HORIZONTAL)
HH POSITION	LL(DIAGONAL)	LH(HORIZONTAL)

FIG.48

RANGE-OVER PIXEL	FIRST DISTRIBUTION PLACE	SECOND DISTRIBUTION PLACE
LL POSITION	LH(VERTICAL)	HL(HORIZONTAL)OR HH(DIAGONAL)
HL POSITION	HH(VERTICAL)	LL(HORIZONTAL)OR LH(DIAGONAL)
LH POSITION	LL(VERTICAL)	HH(HORIZONTAL)OR HL(DIAGONAL)
HH POSITION	HL(VERTICAL)	LH(HORIZONTAL)OR LL(DIAGONAL)

FIG.49

RANGE-OVER PIXEL	FIRST DISTRIBUTION PLACE	SECOND DISTRIBUTION PLACE
LL POSITION	HL(HORIZONTAL)	LH(VERTICAL)OR HH(DIAGONAL)
HL POSITION	LL(HORIZONTAL)	HH(VERTICAL)OR LH(DIAGONAL)
LH POSITION	HH(HORIZONTAL)	LL(VERTICAL)OR HL(DIAGONAL)
HH POSITION	LH(HORIZONTAL)	HL(VERTICAL)OR LL(DIAGONAL)

FIG.50

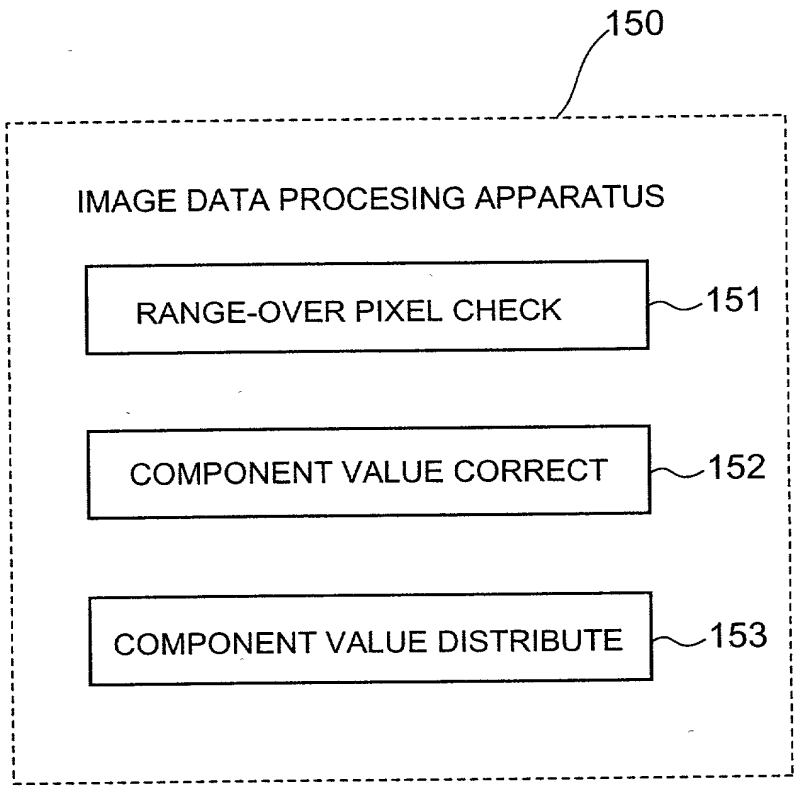

150
IMAGE DATA PROCESING APPARATUS
RANGE-OVER PIXEL CHECK
151
COMPONENT VALUE CORRECT
152
COMPONENT VALUE DISTRIBUTE
153

FIG. 51

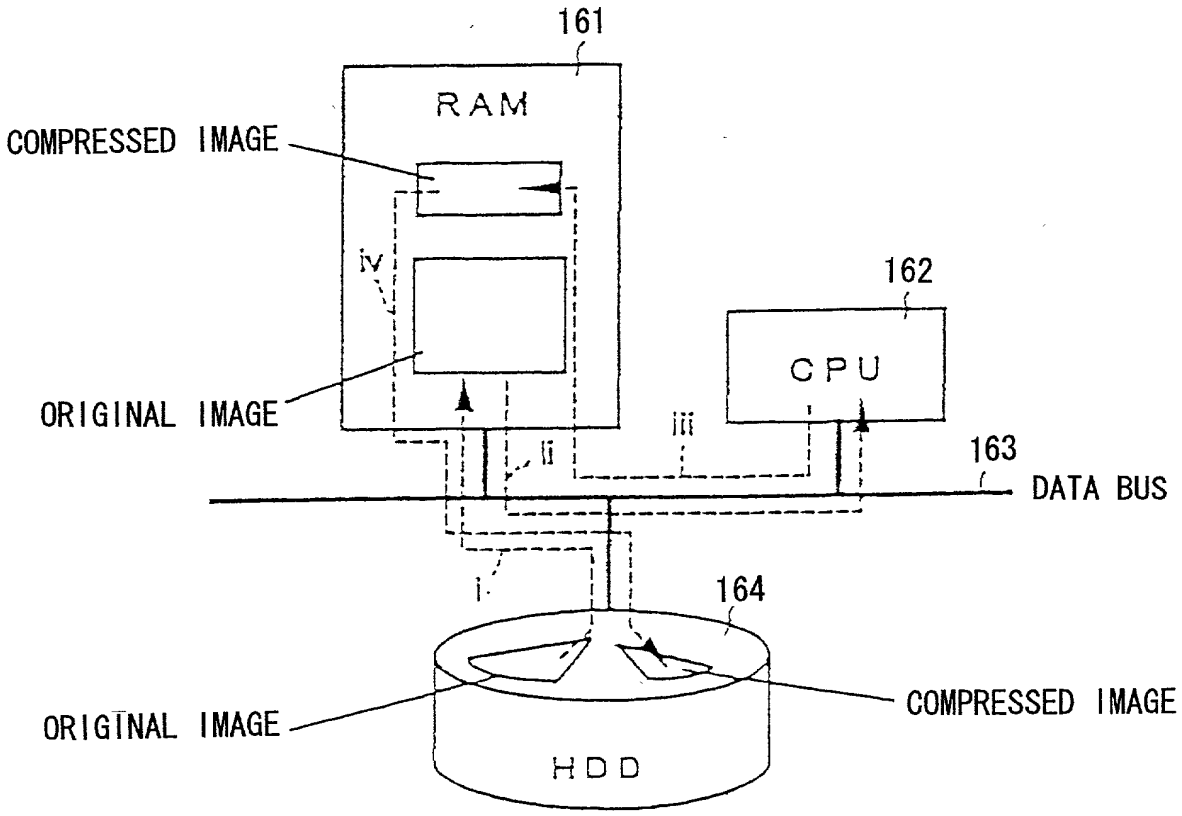

161
RAM
COMPRESSED IMAGE
iv
ORIGINAL IMAGE
162
CPU
iii
ii
163
DATA BUS
i
164
ORIGINAL IMAGE
COMPRESSED IMAGE
HDD

FIG. 52

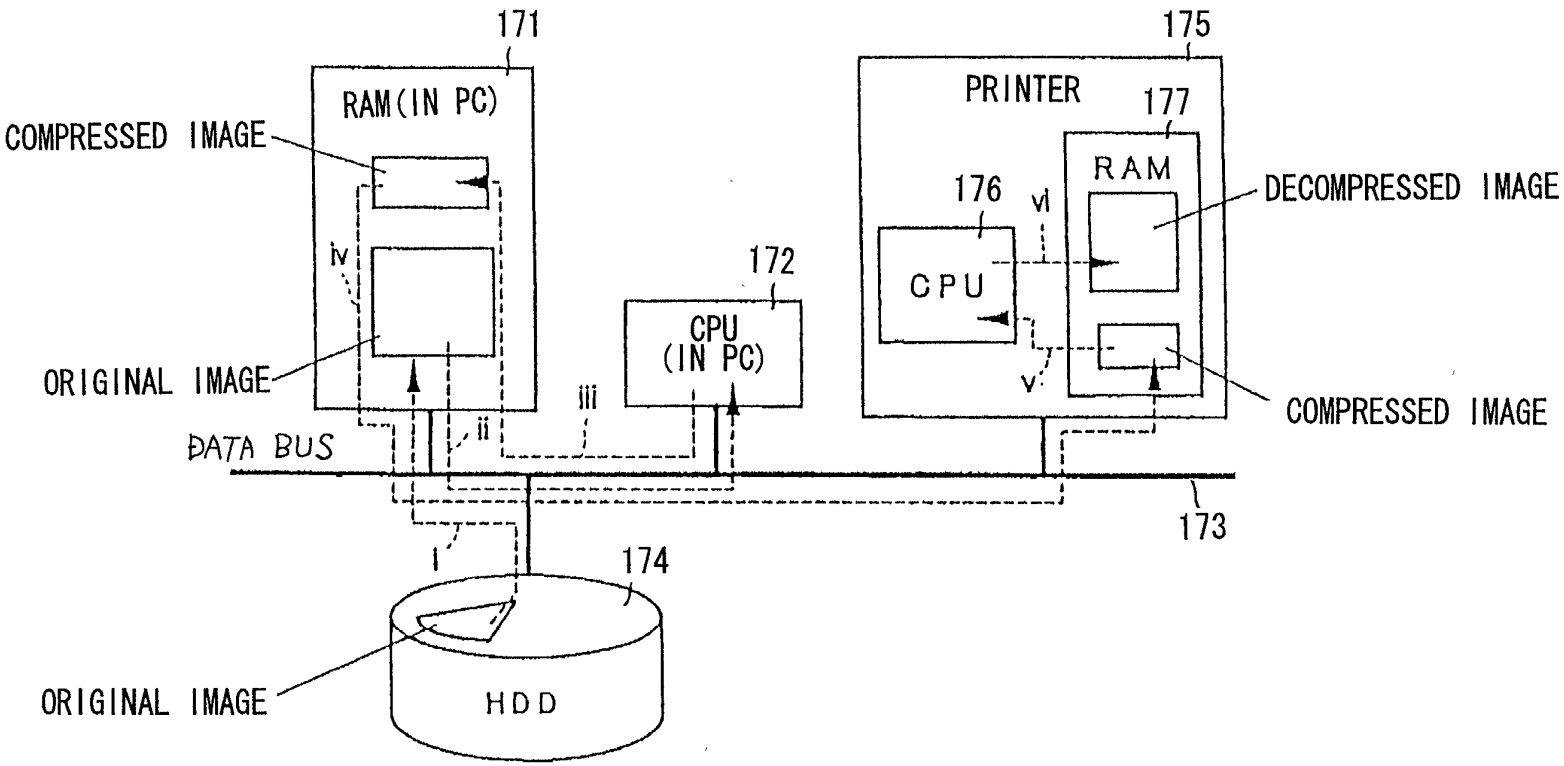

171
RAM(IN PC)
COMPRESSED IMAGE
ORIGINAL IMAGE
iv
ii
iii
DATA BUS
172
CPU
(IN PC)
175
PRINTER
177
RAM
176
CPU
vi
v
DECOMPRESSED IMAGE
COMPRESSED IMAGE
173
i
174
ORIGINAL IMAGE
HDD

FIG.53

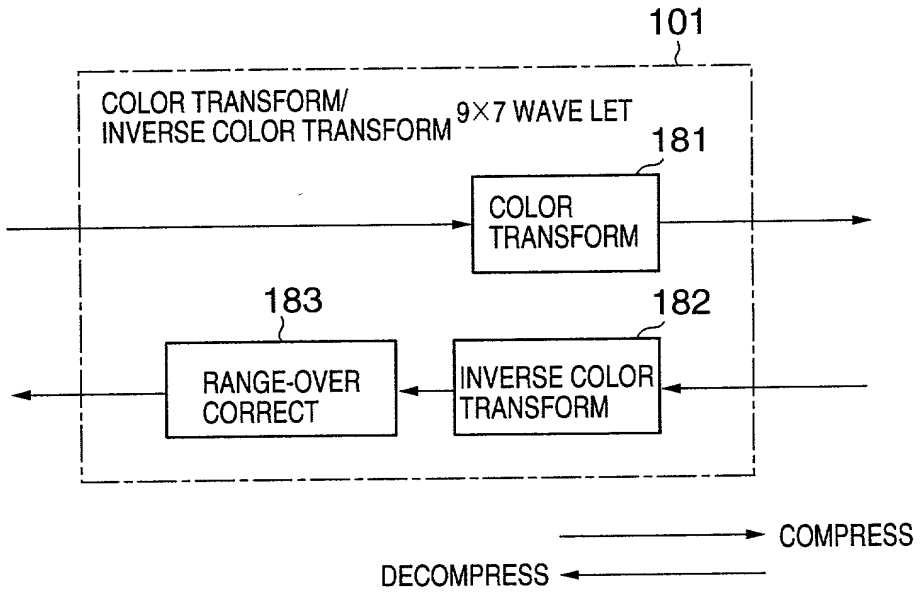

101
COLOR TRANSFORM/
INVERSE COLOR TRANSFORM
9×7 WAVE LET
181
COLOR
TRANSFORM
183
182
RANGE-OVER
CORRECT
INVERSE COLOR
TRANSFORM
COMPRESS
DECOMPRESS

FIG.54

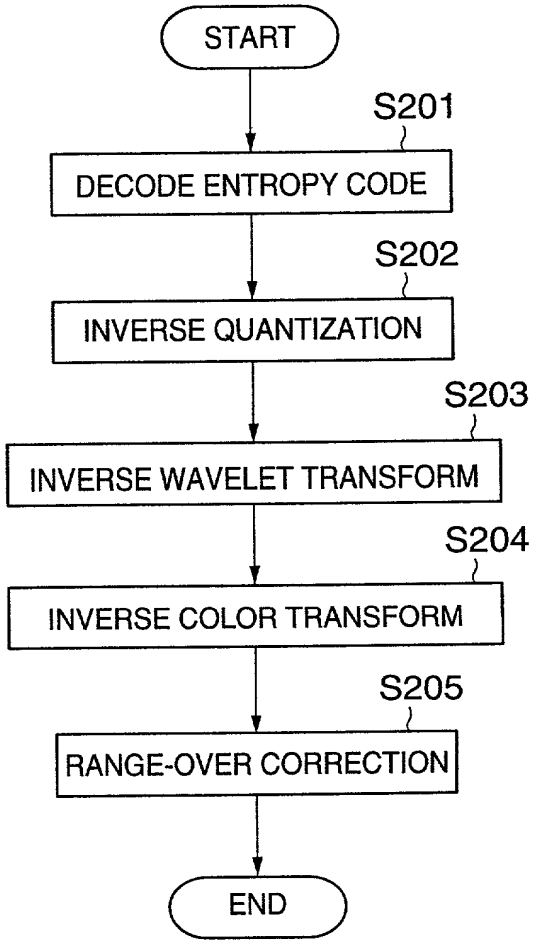

START
S201
DECODE ENTROPY CODE
S202
INVERSE QUANTIZATION
S203
INVERSE WAVELET TRANSFORM
S204
INVERSE COLOR TRANSFORM
S205
RANGE-OVER CORRECTION
END

FIG.55

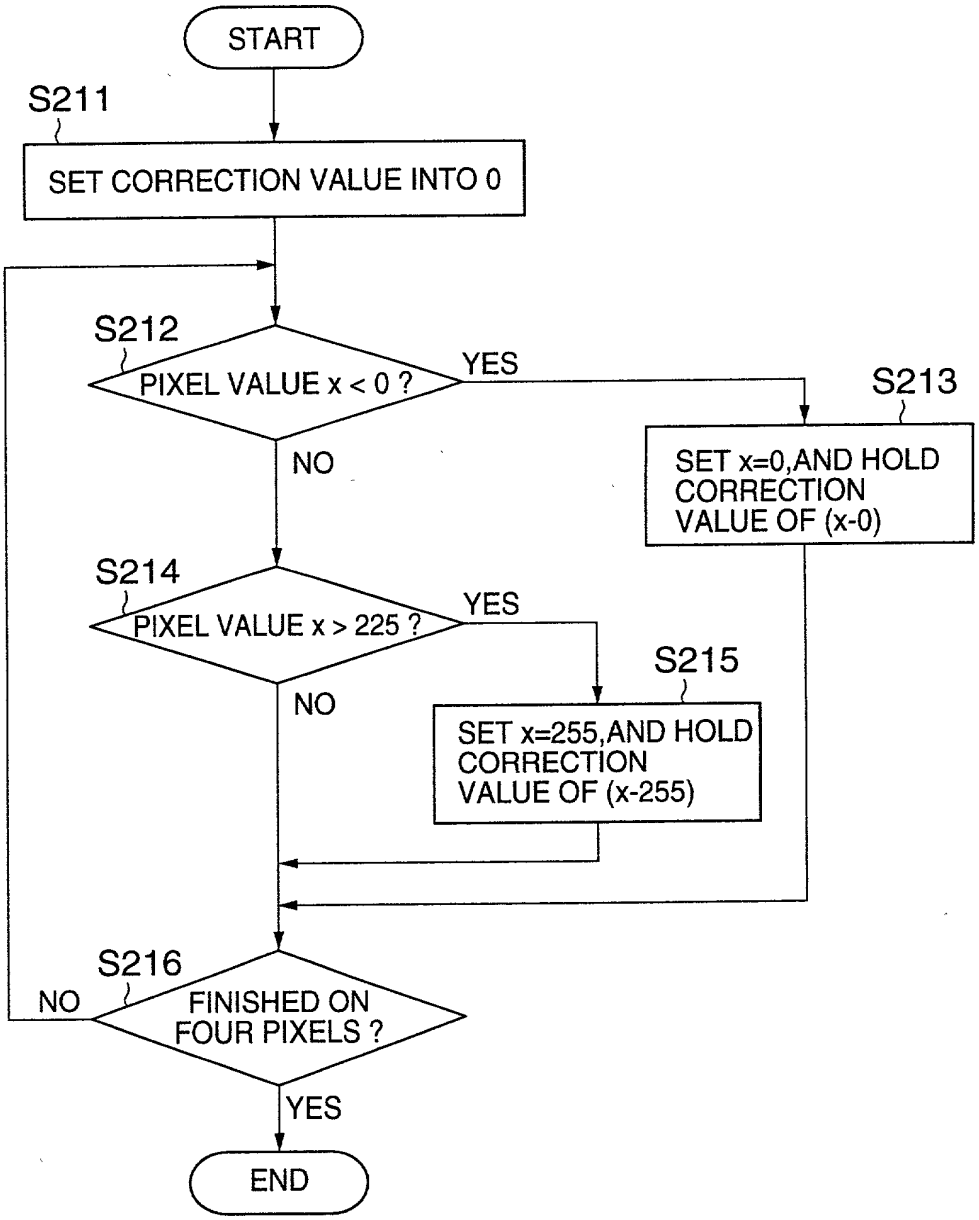

START
S211
SET CORRECTION VALUE INTO 0
S212
PIXEL VALUE x < 0 ?
YES
S213
SET x=0,AND HOLD CORRECTION VALUE OF (x-0)
NO
S214
PIXEL VALUE x > 225 ?
YES
S215
SET x=255,AND HOLD CORRECTION VALUE OF (x-255)
NO
S216
NO
FINISHED ON FOUR PIXELS ?
YES
END

FIG.56

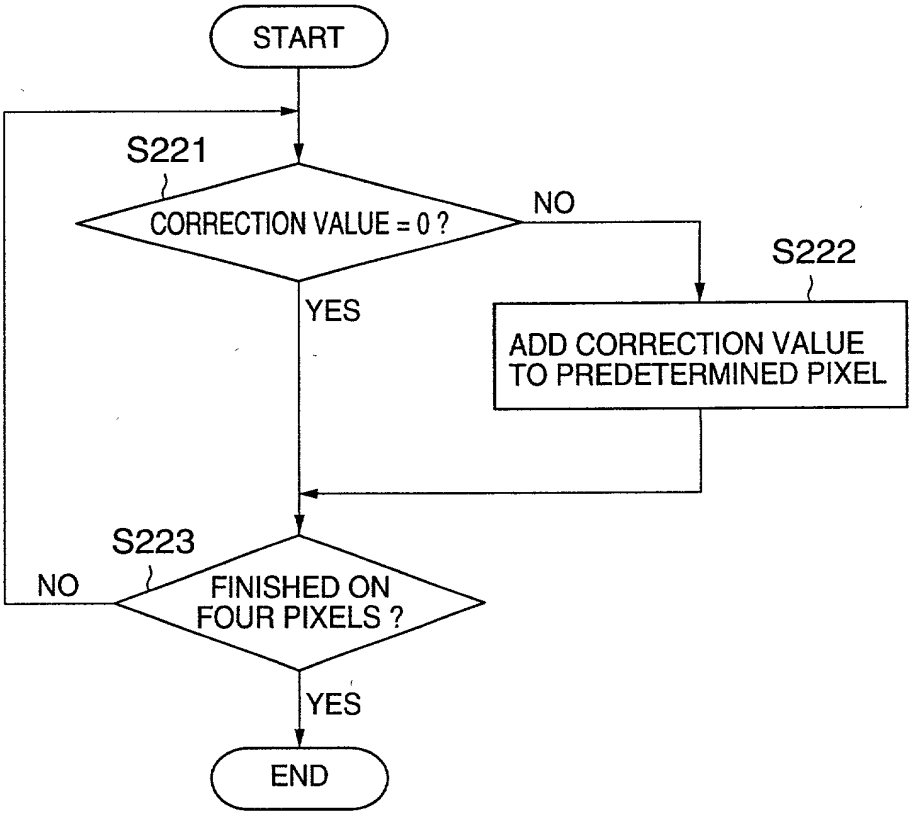

START
S221
CORRECTION VALUE = 0 ?
NO
YES
S222
ADD CORRECTION VALUE TO PREDETERMINED PIXEL
S223
NO
FINISHED ON FOUR PIXELS ?
YES
END

FIG.57

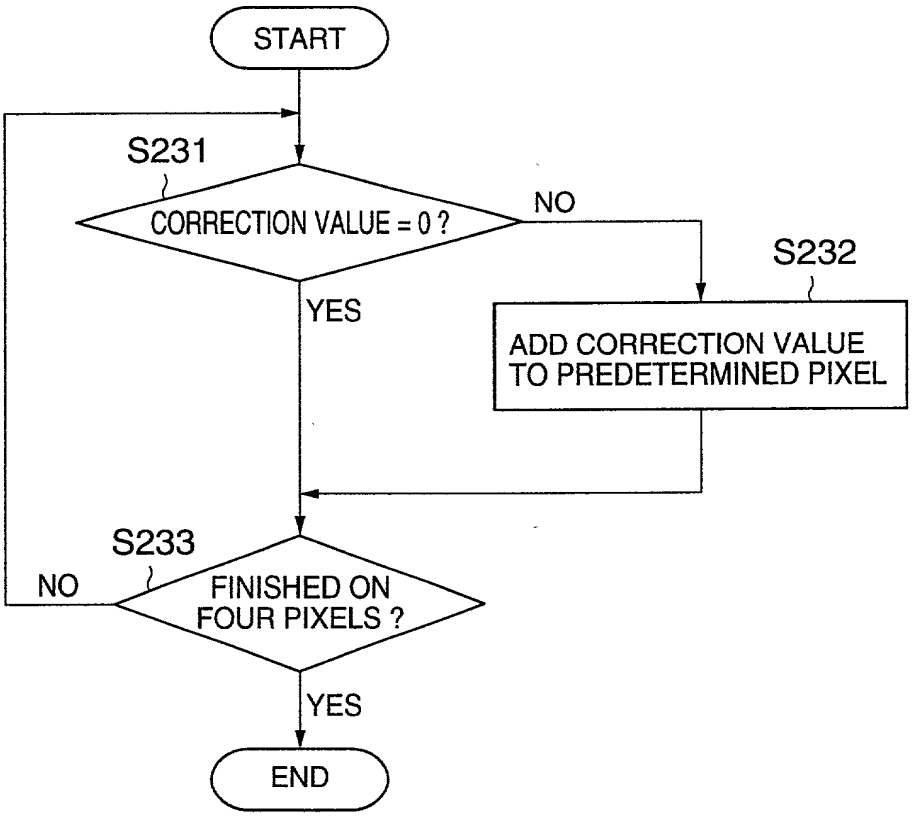

START
S231
CORRECTION VALUE = 0 ?
NO
YES
S232
ADD CORRECTION VALUE TO PREDETERMINED PIXEL
S233
NO
FINISHED ON FOUR PIXELS ?
YES
END

FIG.58

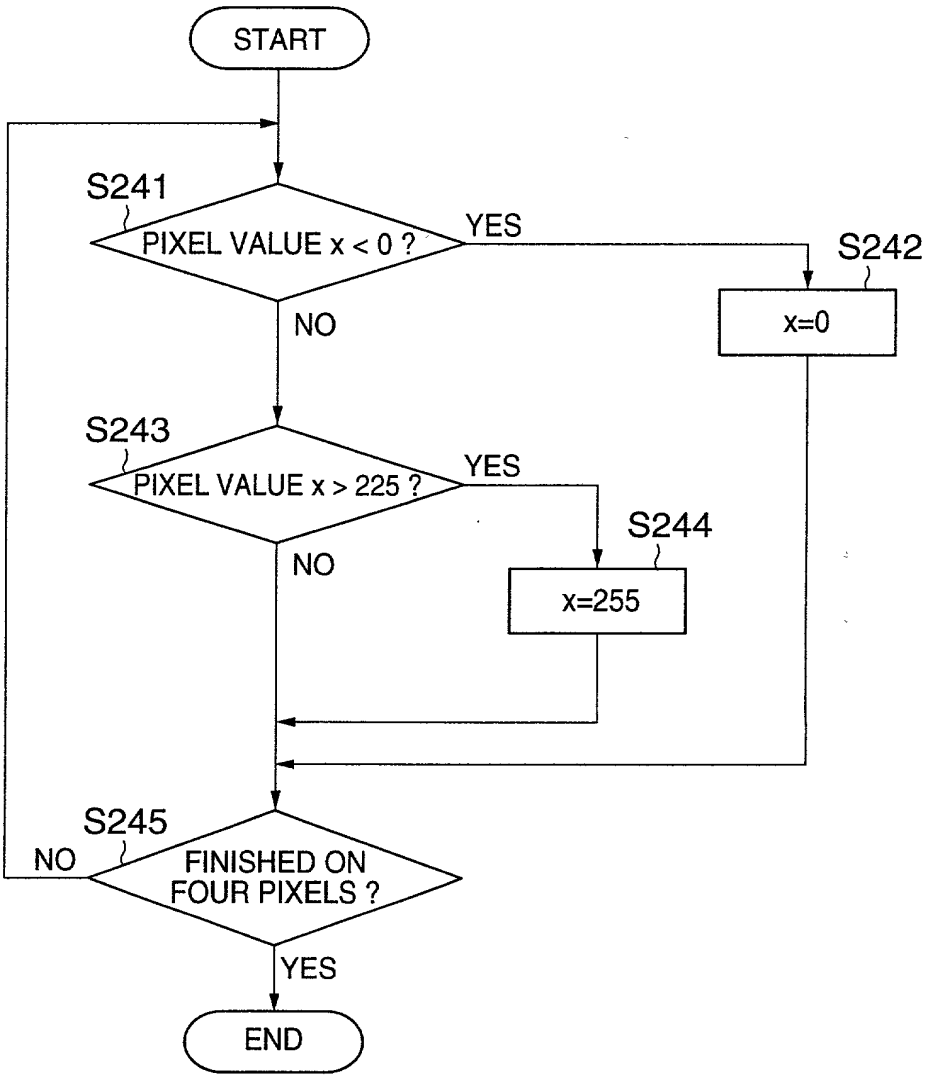

START
S241
PIXEL VALUE x < 0 ?
YES
S242
x=0
NO
S243
PIXEL VALUE x > 225 ?
YES
S244
x=255
NO
S245
NO
FINISHED ON FOUR PIXELS ?
YES
END

FIG.59

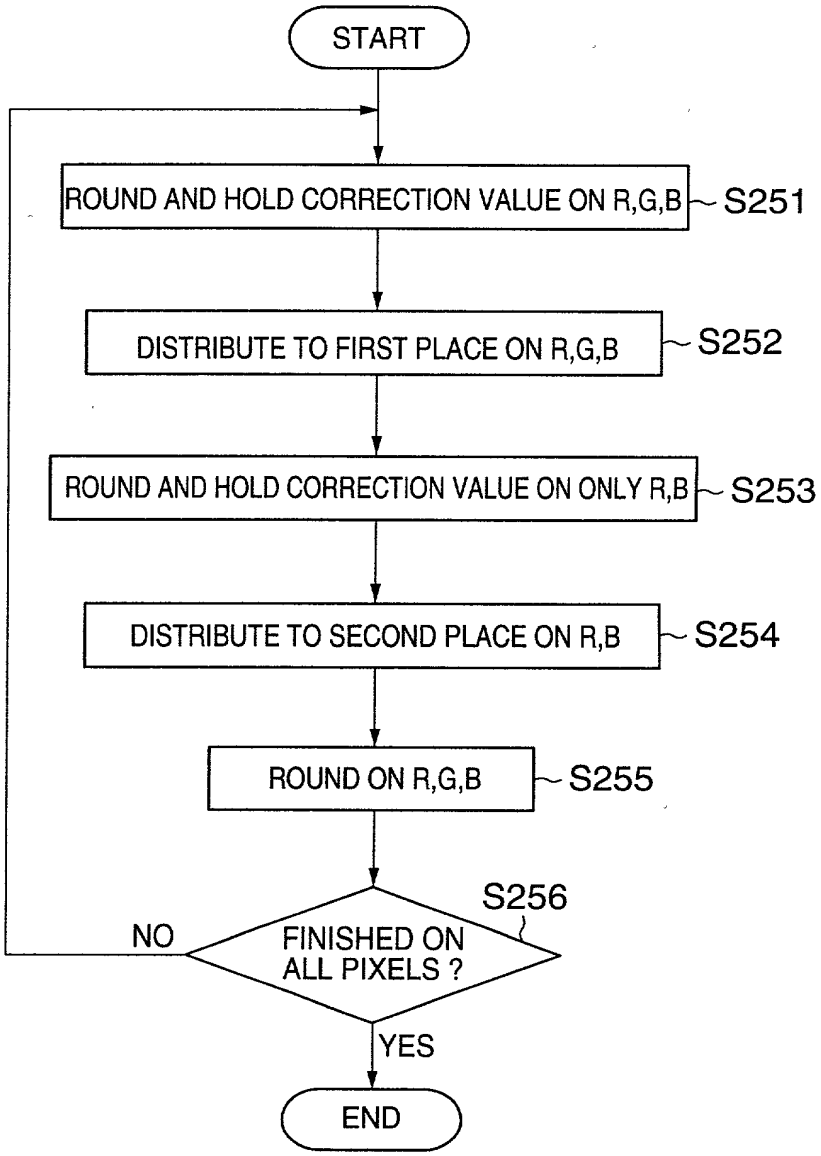
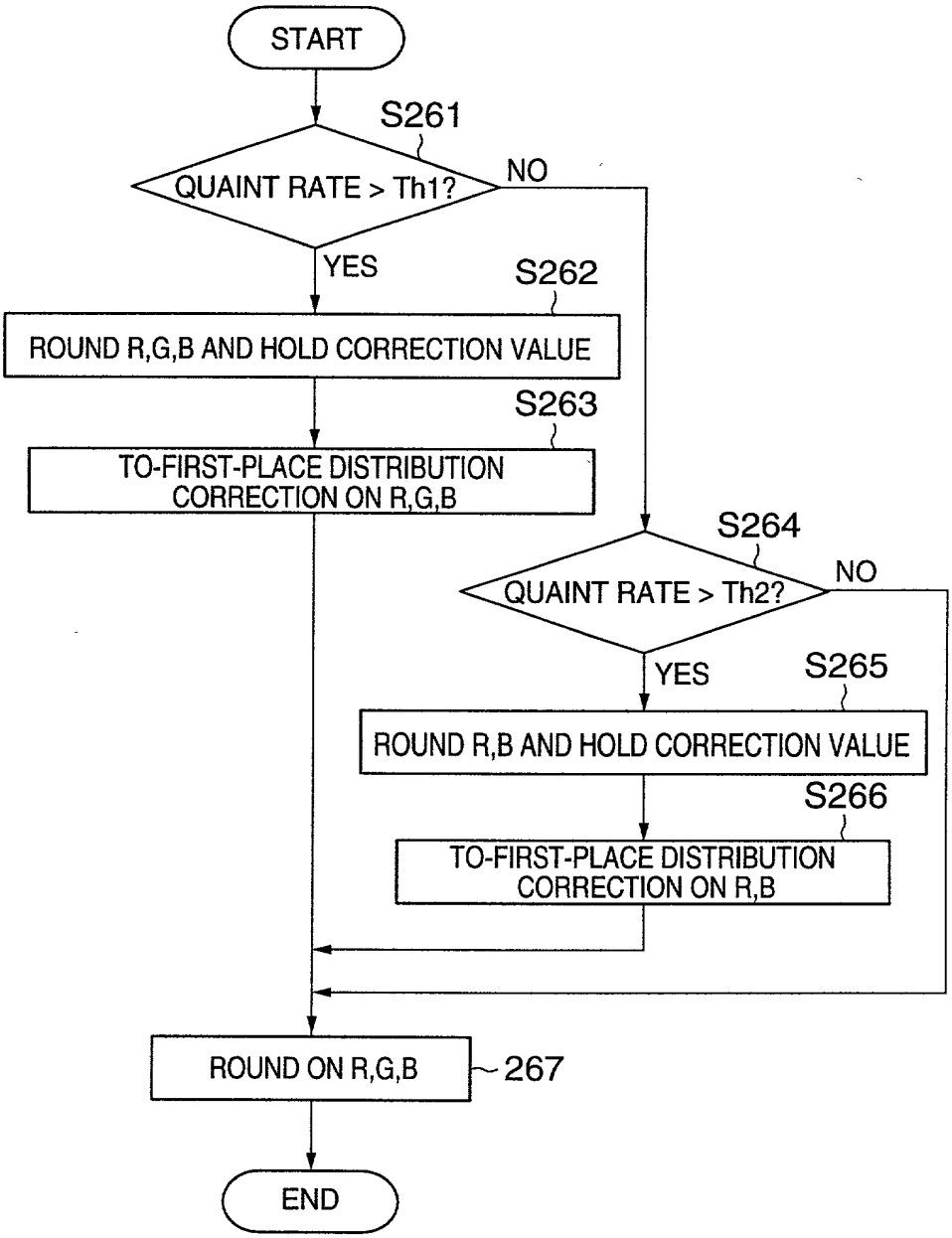

START
ROUND AND HOLD CORRECTION VALUE ON R,G,B
S251
DISTRIBUTE TO FIRST PLACE ON R,G,B
S252
ROUND AND HOLD CORRECTION VALUE ON ONLY R,B
S253
DISTRIBUTE TO SECOND PLACE ON R,B
S254
ROUND ON R,G,B
S255
S256
NO
FINISHED ON ALL PIXELS ?
YES
END

FIG.60


START
S261
QUAINT RATE > Th1?
NO
YES
S262
ROUND R,G,B AND HOLD CORRECTION VALUE
S263
TO-FIRST-PLACE DISTRIBUTION CORRECTION ON R,G,B
S264
QUAINT RATE > Th2?
NO
YES
S265
ROUND R,B AND HOLD CORRECTION VALUE
S266
TO-FIRST-PLACE DISTRIBUTION CORRECTION ON R,B
ROUND ON R,G,B
267
END